POWER

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FRED R. LOW, *Editor*

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The Robot of the Boiler Room

A STORY, fanciful and otherwise, has been written of "Robot," the mechanical man who can do everything but think.

The modern boiler room furnishes an example of selective, directive and operative mechanism that lacks only the simulation of the human form to realize the ideal.

Instead of men pushing barrows or horses dragging carts there is automatic handling machinery that takes the coal from vessel or car or storage and spouts it to the boiler, crushing and weighing it as it goes.

Instead of lines of sweating huskies shoveling coal into the furnaces, the finely pulverized coal is wafted in by the air in which it burns, or mechanical stokers push it either upon a traveling grate or under the firebed, so that its introduction is continuous instead of intermittent, without the admission of copious quantities of cold air, and in the case of the underfeed beneath instead of on top of the incandescent coal so that its volatiles must pass through the fire and be consumed.

Attempts were made to get this result on hand-fired furnaces by reversing the draft. Instead of letting the air pass as usual upward through the grate and fire, it was pulled downward through the newly fired coal, the firebed and the grate. Introducing the fuel at the bottom instead of turning the fire upside down avoids the complication of a water grate, etc.

Instead of the gruelling task of working the fires, turning over the scorching heap of white-hot coal with hand tools, freeing it of ash and clinker and distributing it over the grate, the grate itself moves the fuel along as it burns, discharges its refuse and reduces its clinker to a condition in which it may be handled by the mechanical conveyor.

Besides his rake, hoe, slice bar and coal scoop, a water column and a steam gage were the only tools and guides for their use at the command of the old human fireman.

The "Robot" of the fireroom senses immediately a fall in pressure, adds to the fuel supply and adjusts air and feed water to the increased rate of operation. He can tell at any time the steaming rate of any boiler and how many pounds of steam it is making per pound of coal.

What used to be a hot, dirty, disagreeable manual grind has been so mechanized as to concentrate the human service required into bossing or waiting upon the "Robot." From a job inviting only to illiterate brawn it has become an opportunity for brains and technical training to conduct with intelligence and efficiency the chemical and physical processes involved in converting the latent energy of fuel into the potential power of steam.

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

What the Individual Can Do

IN TIMES of business uncertainty people's thoughts are singularly upon such questions as, What will business leaders do? Will they cancel all orders? Will there be much unemployment? How will it affect me?

They commence to consider things that seldom enter their minds when times are normal, and their mental attunement is apt to misinterpret ordinary events, giving to them an exaggerated significance.

For example, consider the seasonal slowing down of the automobile industry that occurred almost simultaneously with the recent break in the stock market. Many minds immediately reasoned that hard times were upon us and a greatly reduced market for automobiles was inevitable.

While some reduction may occur, the luxury class will be most affected, and this only to an extent which may be estimated by the statement of a prominent oil refiner that all luxury cars represent but ten per cent of the total gasoline consumption.

It was largely to replace such popular misconceptions with the true facts that President Hoover's conferences were recently called in Washington. And the meetings held there have aided greatly in allaying unwarranted nervousness.

Nevertheless, they will not have completely accomplished their purpose until the individual realizes it is his duty to accept the facts and act according to them. In the home, affairs should proceed normally, without curtailment in the mode of living but with due regard to the usual rainy-day economies.

In the power house, men should be alert to the possibility of better operating economy. With low money rates as a result of the return of capital to industry, the opportunity for making long-needed improvements is exceptionally favorable. If savings can be effected with modern equipment; by modifications to present equipment; by combining power service with heating and process steam; by changes of any sort—the work should be started now. Whether from operator, chief engineer or superintendent, the subject should receive prompt attention.

Corrosion With Low Stack Temperatures

IN THE struggle to capture the elusive B.t.u., heat-recovery equipment has come into wide use, with the result that stack temperatures are now very much lower than formerly. But this curtailment in loss of heat up the stack has been accompanied, in numerous instances, with greatly increased maintenance costs. Many plants that have been operating with low exit-gas temperatures report serious stack corrosion, as well as corrosion in the heat-recovery equipment itself. The higher the sulphur in the coal the more aggravated this may become.

This condition is attributable to a lowering of the temperature below the dew-point of the sulphuric acid vapor in the gases. It has been particularly noticeable where boilers are operated on light load or where the banking periods are appreciable.

An especially vulnerable point of attack in the stacks has been at the joints, where the tops of the inside plates form ledges upon which ash and moisture collect. Such sections might well be protected in advance by welding in a strip of metal to provide a chamfer instead of the ledge. Carrying stack linings to greater heights may be found expedient in some cases.

These experiences emphasize the importance, when designing a plant, of weighing all factors, such as heat expenditure, first cost, fuel, maintainance and replacement, in their relation to probable operating conditions. Too often thermal considerations are allowed to dominate the thinking.

Building-Operation Responsibilities

ENGINEERING responsibilities in the operation of large modern buildings may exceed those in industrial plants. A power failure might occur in an industrial plant and cause little inconvenience, but in a large modern hotel, office building or department store, such a happening might be disastrous. The population of these buildings may reach the proportions of a sizable city. A modern hotel may have populations up to five thousand people and department stores as high as thirty thousand. It is not difficult to imagine what might happen if one of these places were left without elevator service and lights. If the power supply failed in an industrial plant, the worst thing that the management would have to face would be loss of production; but in a department store or hotel the consequences could be much more serious.

Not only have the power requirements of these buildings grown in size and responsibility to where they exceed those of many large industrial plants, but the variety of services has increased enormously. For ice, cold storage and air conditioning, refrigerating plants of several hundred tons capacity are installed. The amount of water may exceed a million gallons a day. Vertical transportation may require forty or more elevators and an equal number of escalators. The ventilating and

heating system may have a thousand horsepower in motors for its operation, not considering the other equipment. To operate these and many other services successfully, calls for high engineering and executive qualifications in the one responsible for the job.

Annual expenditures may run into hundreds of thousands of dollars, consequently the opportunities for economies or losses are very large. In one plant the fuel bill alone runs well over one hundred thousand dollars a year. A ten per cent loss in this item alone would be over ten thousand dollars, and ten per cent does not cover the whole range between good and poor operation. Maintaining a smooth-running and efficient organization, the purchase of supplies and intelligent solution of the many engineering problems that arise in the operation of such plants, may well be a challenge to the resourcefulness of any engineer.

The Future Trend of Steam Pressures

WILL steam pressures go on up? Or will they come down a peg? Perhaps both, simultaneously, if certain things happen in the realm of steam temperatures. The trends of pressure and temperature are closely related in central stations and other condensing steam power plants. Yet the idea of a simultaneous up-and-down trend in steam pressures may seem illogical until one notes that reheating, as determined by initial steam temperature, is a major factor. At present, 750 deg. F. is generally taken as the practical limit of steam temperature by American engineers. This, in turn, limits the pressure, without reheating, to about 450 lb. Several 600-lb. reheating plants have been built, but the present trend is to stop at 450 lb. or jump to 1,200 or 1,400 lb. In short, the range from 600 lb. to 1,000 lb. has become a sort of economic "dead space." The reason, as has been pointed out before, is the sharp jump in cost when reheating enters. Any fuel cost and load factor that would justify reheating operation would likewise justify the additional fuel economy of 1,200 lb. operation, since the 1,200-lb. plant costs little more than the 600 lb.

But all this, it must be remembered, hinges on a limiting steam temperature of 750 deg. If that is raised everything will be changed. At the present time the Detroit Edison Company is experimenting with steam superheated to 1,000 deg. If this and similar work should eventually lead to the adoption of 850 deg., say, as the "standard" steam temperature, it would be practicable to operate turbines at 800 or 900 lb. pressure without reheat.

The plant designer would then be presented with an entirely new set of possibilities. Pressures of 1,200 or 1,400 lb. would cease to be particularly attractive, since the additional fuel saving over an 800 lb. plant would hardly justify the additional investment for reheating. He would therefore drop to 800 lb. or jump to some pressure far above 1,400 lb. This simply means that the economic "dead zone" of pressure slides up as initial steam temperature increases. Now it runs from 500 to 1,000 lb. or thereabout. With 850 deg. steam temperature it might shift to the range from 900 lb. to 1,800 lb. approximately.

The results of experiments such as that going on in Detroit may, therefore, have an influence on station design extending far beyond the superheater, valves and other metal parts exposed to maximum steam temperatures.

Engineering and Economics —Not Political Expediency

IN THE ninth annual report of the Federal Power Commission there is a section calling attention to the lack of public co-operation in the interest of water power development.

Water power is the only natural resource susceptible to commercial development that does not decrease with use. Therefore, as a conservative measure it should be utilized to its economic maximum. Aside from power production, there are other benefits that accrue from water power development. In arid regions, water in storage after passing to the wheels of power-generating units is available for irrigation. Power developments on rivers often improve navigation. In many places lakes are formed that provide recreation centers. Other developments combine power and municipal water supply. Another and one of the most important benefits from water-power development is river regulation and flood control.

In view of these advantages it should be expected that water power development would receive the utmost public encouragement. But, on the contrary, the report points out, the obstacles that must be overcome appear to be constantly increasing. Although it is becoming more difficult for water power to compete economically with steam, state legislative bodies continue to insist upon extraordinary taxes and other restrictions on hydro power. Such taxes encourage the use of resources that are destroyed in their utilization and discourage the employment of water power, which is our only self-perpetuating natural resource.

Long litigations over water rights, years of conflict between federal and state interests, have caused many delays in water power development. Then there are those interests which have the protection of scenery as their object. To these can be added others, such as the fish and sports interests, all of which have claims inimical to the development of hydro-electric power.

The benefits to flood control from water power development have been well demonstrated, but there exists the spectacle of a state fighting for the flood waters of another, although at times this same flood water does it serious damage. While such an attitude is taken, water power and other developments will be delayed.

One of the greatest boons to water power would be the application of less political expediency and more sound engineering and economics in its development.

A.S.M.E. Holds *Fiftieth* A

CHARLES PIEZ
President

ANOTHER annual meeting of the American Society of Mechanical Engineers has just drawn to a close with an attendance of approximately two thousand. The increasing activities of the society made it necessary this year to add one more day to the meeting, but the individual sessions, on the whole, carried fewer papers. The program covered a large diversity of subjects and, with the exception of the hydro sessions, there were fewer papers devoted to strictly power subjects than in some former years. This was offset, however, by more special committee meetings, many of which were of particular interest to power men.

Executive Committee Reconstituted

Co-incident with the annual meeting sessions of the society, the Council held its regular business session. In the absence of President Elmer E. Sperry, who is on his way home after attending the World Power Conference in Japan, Vice-President E. A. Muller presided.

Following the regular business of the meeting, which included the reading of the reports of standing committees, the report of the special committee upon the reconstitution of the Executive Committee of the society was received. The report provides for modification of the constitution and by-laws which will require the Executive Committee in the future to be composed of a president, two vice-presidents, two managers and chairmen of the standing committees on finance, professional divisions and local sections, the last three members having no voting power. It also provides that meetings of the Executive Committee shall be held monthly. Under the new plan the Executive Committee will receive the benefit of the views and assistance of the three chairmen in administering society affairs and will thus be brought more closely than before into contact with the entire society membership.

Stress was laid upon the desirability of securing more co-operation from industrial executives in releasing the engineers of their organization for attendance at the annual meetings. While the attendance is good and showing a healthy growth, subjects of the papers presented at the annual meetings are of growing importance, and advantage should be taken wherever possible of the opportunity to have engineers listen to the verbal presentations and discussions that follow. Far more benefit will be derived from the work of the society by this method than through simply reading the articles in the transactions.

A plan was adopted to have the 50-year progress reports of the society presented in *Mechanical Engineering* with bound copies of the entire reports available for purchase.

A plan is under consideration by the Library Committee to extend the library service through a series of branches that ultimately will be so located as to make the library service available to engineers throughout the United States and Europe.

Reading of the annual report of the Council and standing committees and presentation of awards were the outstanding features of the business meeting on Monday evening, Dec. 2. In the absence of President Elmer A. Sperry, Vice-President E. A. Muller presided.

Many International Contacts

One significant fact brought out in the report of the Council, which was given by C. E. Davies, assistant secretary, was the increase in important international contacts made by the society during the year. The society participated in five notable foreign conferences—the Paris Conference on Scientific Management, the London meeting of the Advisory Committee on Steam Turbines of the International Electro-technical Commission, a conference in London of four countries engaged in research on the properties of steam, the World Engineering Congress and World Power Conference in Tokio—besides conducting a joint research in Germany with the Verein Deutscher Ingenieure on fluid flow. The normal activities of the standing committees showed satisfactory growth, according to the report, which indicated continued expansion of the society's endeavors.

Awards were made by Dr. Ira N. Hollis, chairman of the Committee on Awards, to Arthur M. Wahl, East Pittsburgh, Pa., for his paper entitled "Stresses in Heavy Closely Coiled Helical Springs," and to Frank V. Bistrom and William W. White, University of Washington, for their paper entitled "An Investigation of a Rotary Pump." Mr. Wahl received his award in person, but Messrs. Bistrom and White were unable to attend the meeting, so W. L. Dudley, Seattle, Wash., accepted the award for them.

Announcement of the personnel of the Nominating

th ANNUAL MEETING

Committee for 1930-1931 was made by J. M. Foster, Raleigh, N. C., as follows: Ralph Earle, Worcester, Mass.; Vincent M. Frost, Newark, N. J.; W. F. Dixon, Elizabethport, N. J.; Eugene W. O'Brien, Atlanta, Ga.; C. S. Robinson, Cleveland, Ohio; John Hunter, St. Louis, Mo.; S. H. Graf, Corvallis, Ore.

Dr. Hollis read resolutions in tribute to W. R. Warner, sixteenth president and honorary member of the society, which were unanimously passed by a rising vote. Since no new business was brought up at this time, the meeting adjourned.

No presidential address was given on Tuesday evening, due to the fact that President Elmer A. Sperry is journeying back from the World Engineering Congress at the time of the meeting. Vice-President E. A. Muller presided and two papers were presented, as well as the report on the election of officers for 1930 and the introduction of President-Elect Charles Piez. The high light of the social program followed—the president's reception and dance.

PAUL DOTY
Vice-President

CONRAD N. LAUER
Vice-President

Business Economically Sound

The first paper, entitled "Economic Changes," was given by Edward E. Hunt, secretary of President Hoover's Committee on Recent Economic Changes. Using the report of that committee as a background, Mr. Hunt endeavored to bring out the salient features of the present business situation and answer the question of how far the stock market crash has affected industry. "American business," he said, "has been characterized in the last few years more by changes in tempo than in kind. After a period of spectacular wastefulness, industry gradually steadied, and is today assuming a nice sense of balance. Evidences of this equilibrium were apparent in the early part of 1929. Far from being upset by the market crash, these evidences are stronger today than they have been at that or any previous time." President Hoover's conferences are aimed at controlling this balance.

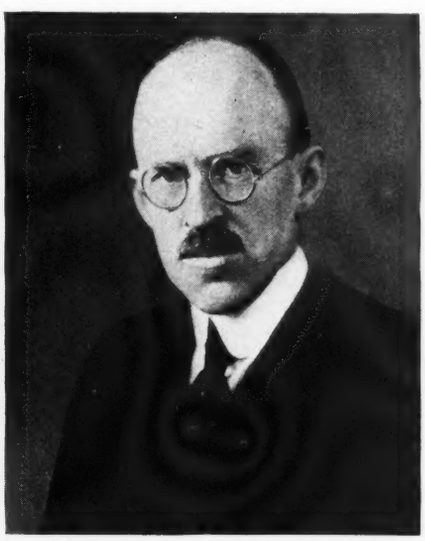
Engineering Careers Analyzed

Engineers suffer unduly from an inferiority complex, according to L. W. Wallace, executive secretary of the American Engineering Council, who gave the second address. In their paper entitled "Engineers in American Life," he and J. E. Hannum, editor of the *Engineering Index Service,* attempted to dispel this self-depreciation by an analysis of the careers of 2,858 engineers and architects listed in the current "Who's Who in America." Calling their study an "assay," the term used by President Hoover, Mr. Wallace said, "The findings of this assay clearly show that engineers and architects are versatile, not narrow; internationally, not provincially, minded; leaders, not followers; scholarly, not unlearned; cultured, not rude; humane, not cruel; lovers, not haters, of mankind."

An important point was brought out in this paper when Mr. Wallace stated, "Some of those included in the sample are not at present practicing engineers. But an engineer is no less an engineer because for the time being he is president of a bank, a university, an opera company or a hotel company. Moreover, he is no less an engineer because he happens to be governor of a commonwealth,

ERNEST L. JAHNCKE
Vice-President

RALPH E. FLANDERS
Vice-President



a United States Senator, a member of the Cabinet or the President of the United States.

"Members of the engineering profession very frequently complain that engineers are not given proper recognition by the public, and then, just as soon as the engineer steps out of the bounds of engineering to the slightest degree, they disown him. No wonder many engineers become lost to the profession."

Following this paper, the report on the election of officers was read by Thomas Norman. Officers elected for the following year are: President, Charles Piez, chairman of the board, Link-Belt Company, Chicago, Ill. vice-presidents, Paul Doty, chairman of the board, Minnesota State Board of Registration, St. Paul, Minn., Ralph E. Flanders, manager, Jones & Lamson Machine Company, Springfield, Vt., Ernest L. Jahncke, assistant secretary of the Navy, Washington, D. C., and Conrad N. Lauer, president, Philadelphia Gas Works, Philadelphia, Pa.; managers, Harold V. Coes, Ford, Bacon & Davis, New York City, James D. Cunningham, president, Republic Flow Meter Company, Chicago, Ill., and Clarence F. Hirshfeld, chief of research department, Detroit Edison Company, Detroit, Mich.

President-Elect Charles Piez was then introduced. After a few humorous remarks on the conservation of oratory, he stated his platform for the year, which consisted of a provision for regional distribution of authority within the society in order to put "the fine executive ability of the vice-presidents to work."

Support for Educational Work Urged

"If the engineering profession is going to maintain its present high standards, ever-increasing attention will have to be directed toward the educational institutions upon which it is founded," Dr. James Rowland Angell, president of Yale University, told the society at its annual banquet at the Hotel Astor on Wednesday evening. At present, he declared, the most able teachers are being tempted from the technical schools by the opportunities for research and advancement afforded by the great laboratories established by our industries. As a deterrent to this migration, he suggested the endowment of chairs in the schools that would attract men of the highest character and give them adequate financial rewards and opportunities for research.

Other speakers at the dinner were Dr. Ing. E.h. Oscar von Miller, of Munich, Germany; William L. Abbott, past president of the society, and Charles Piez, president-elect. Dr. Harvey N. Davis, president of Stevens Institute of Technology, presided.

One of the most profitable conferences of the annual meeting was an informal session attended by about forty industrial power engineers to discuss their mutual problems and work out a plan whereby the Power Division can be made of greater service to them. A committee was appointed to correlate the various problems and outline a program for their handling.

At the meeting of the Executive Committee of the Hydraulic Division, the sub-committee on standardizing shaft couplings reported. The work the committee has carried on for the past two years has resulted in the establishment of a uniform and standardized design for couplings connecting hydraulic turbines to electric generators or other driven machinery.

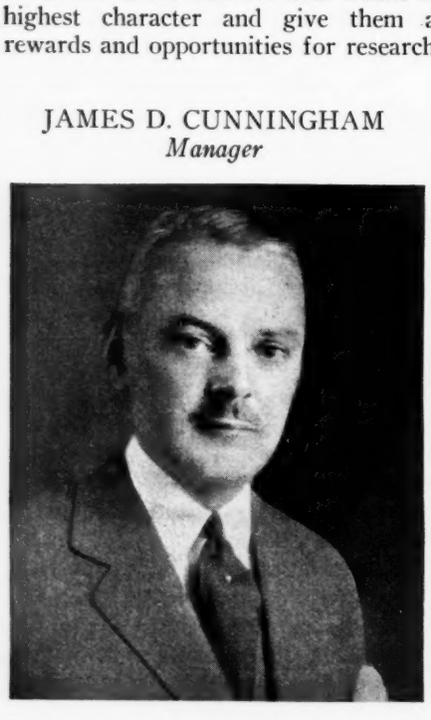
The Allis-Chalmers Manufacturing Company and the I. P. Morris & De La Vergne Company have already adopted the standards. When the electrical companies and other hydraulic concerns do likewise, a bothersome detail that has heretofore required special treatment in each case will have been eliminated in the relations between hydraulic turbine and electric generator manufacturers. The new standard has also been adopted by the Canadian Chalmers Company and the Dominion Engineering Works, of Montreal.

E. M. Breed, president of the Pelton Water Wheel Company, in San Francisco, was elected to membership on the Executive Committee.

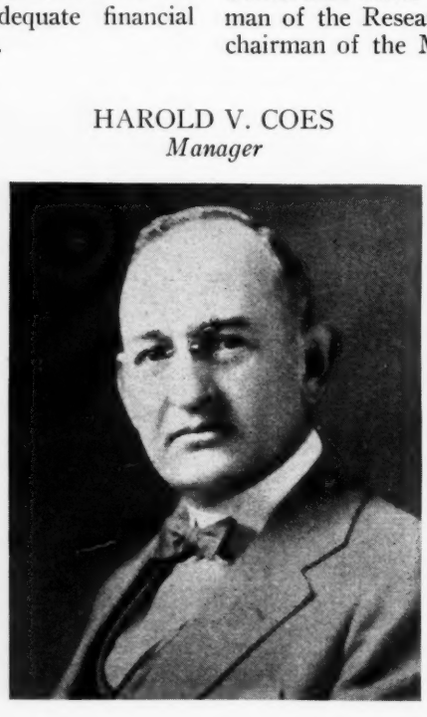
The Executive Committee elected W. M. White, chief engineer of the Allis-Chalmers Company, chairman for the ensuing year; Byron E. White, chief engineer of the Utica Gas & Electric Company, secretary. Blake R. Vanleer will continue as chairman of the Papers and Meetings Committee.

Other committeemen who will continue with their work of last year at the request of the incoming chairman are: George R. Orrok, chairman of the Contacts Committee; Prof. R. L. Daugherty, chairman of the Conference Table Committee; Prof. C. M. Allen, chairman of the Research Committee; and Byron E. White, chairman of the Membership Committee.

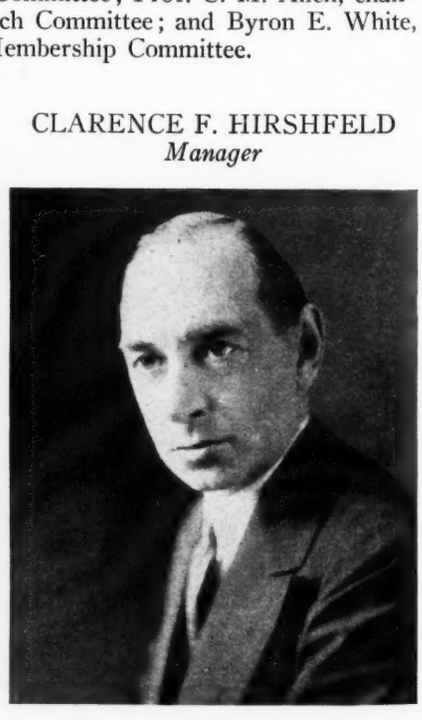
JAMES D. CUNNINGHAM
Manager



HAROLD V. COES
Manager



CLARENCE F. HIRSHFELD
Manager



Central Station Power

Departing from former procedure, but one session was devoted to power. This dealt with problems of primary interest to the central station. Two papers were presented, in addition to the progress report of the Power Division, one a report of studies made to determine the factors affecting the availability of steam-generating units; the other a discussion of the economic factors involved in the use of larger boiler units. The large number of written discussions was a feature of the session.

Economic Study of Boiler Size

THE effect of boiler capacity on operating characteristics and investment was discussed in a paper by Frank S. Clark, consulting engineer, Stone & Webster Engineering Corporation, Boston, Mass. Following is a brief abstract of Mr. Clark's paper:

In the early days of the steam turbine, limitations other than the ability of the boiler to generate steam held the sizes down, so that a number of boilers were required to serve one unit. These early boilers were limited in size because of inability of combustion facilities to burn the fuel in sufficient quantities, and of the furnace walls to withstand the punishment resulting from high rates of combustion. Impure feed water and also the maintenance of grates and walls caused outages for cleaning and repairs, thus increasing the number of boilers necessary to insure reliability of operation.

The advent of the mechanical stoker increased the fuel-burning ability. Then, air-cooled and water-cooled furnace walls were developed to remove the limitation of unprotected refractories. Pulverized coal gave added momentum to increased rates of evaporation. With these changes came greater reliability, reducing the necessity for spare equipment to a point where it is possible to design a plant with a single boiler serving one turbine-generating unit.

Today there are in operation in this country a number of boilers with steaming capacities of over 400,000 lb. per hour each, and some few, on order or being erected, the output of which will be upward of 800,000 lb. per hour. This increase in steam capacity has been accompanied by increases in the steam pressure and temperature, which, with greater efficiency of steam utilization, has decreased greatly the amount of steam required per killowatt-hour.

Boiler plant investment costs are largely determined by size of individual steam-generating units and output obtainable from each unit.

The size and number of boilers affect the cost, not only of these units themselves, but also of the equipment that goes with them and of the building. For a given output the percentage of building space devoted to aisles and firing floors decreases appreciably with the increase in the size of boilers. There is also a saving in building steel work, piping, and equipment for fuel-handling and burning.

In the furnaces the setting walls have less area per unit of furnace volume as the combustion space increases. Boilers themselves are less expensive per unit of output in larger sizes. There is likewise a saving in fans, flues, economizers, air heaters and other auxiliary equipment.

The effect on cost of boiler capacity is shown more clearly in Table I.

TABLE I—BUILDING AREAS AND INVESTMENT COSTS OF BOILER PLANTS

Number of boilers	4	6	8	12
Sections per boiler	60	40	30	20
Relative building area, per cent	100.00	112.00	127.00	133.00
Relative investment cost, per cent	100.00	112.00	124.00	142.00
Proportional cost of main items of construction and equipment:				
Building and foundations	16.10	16.50	16.70	17.10
Boilers, superheaters, settings, etc	32.00	33.00	34 60	38.00
Draft and feedwater systems	22.40	22.40	22 00	19.80
Piping	9.60	9.50	9.20	9.00
Fuel and ash handling	7.60	7.40	7.20	6.70
Fuel preparation	9.60	8.60	7.90	7.00
Auxiliaries	2.70	2.60	2.40	2.40
Total	100.00	100.00	100.00	100.00

In some cases the length of drum that it is possible to manufacture and properly support limits the size of individual units. For the riveted type, it is possible to obtain drums giving a furnace width of about 39 ft., with only end suspension necessary. For pressures involved the use of forged drums, the limit is the size of the ingot from which the drum is forged. At present this would allow a furnace width of about 43 ft. On account of the thickness of the drum shell the suspension is not a serious problem.

Boiler surface can be provided to absorb all the heat that can be liberated in a given furnace, and the present design can recover economically. It therefore becomes a question of the method of fuel burning. Fuels burned in suspension permit the efficient use of the whole furnace volume.

The burning of coal on a grate involves a large fuel bed with proper air supply and distribution. Consideration must also be given to the preheating of the air to a temperature that will not cause binding of moving parts of the grate, or burning of the parts. With both methods of firing the capacity may be limited by the clogging of the passages around tubes by molten ash. This is more serious with ash having a low fusion temperature.

In the discussion, prediction was made that the trend toward larger sizes and greater capacities would continue. Present boiler limitations would be extended by the use of small tubes and forced circulation, permitting more heating surface in a given space and making possible designs of gas passages that will maintain more nearly the ideal velocity of the gases. As the limitations of powdered-coal burning were a function of three furnace dimensions, as compared to two for stokers, it was predicted that the former method of combustion would extend fuel-burning capacity beyond anything possible with stokers and it would be developed to meet the demand for increased capacity for a considerable period of time to come.

A logical method of design that would secure the simplest and most economical steam-generating unit was outlined. By careful study it had been possible to reduce the total heating surface at least 50 per cent and still maintain the same efficiency. Relative values of various types of plants were given and emphasis placed on the importance of other factors, such as the cost of money, in addition to physical and thermal considerations.

Performance of Boiler Units

AT THE request of the Central Stations Committee of the Power Division, C. F. Hirshfeld and G. U. Moran undertook to determine what factors seem to be most responsible for steam-generating unit outage, the results of which study are recorded in this paper.

Daily operation logs were printed and sent to the operators of 230 boilers scattered about the country in 64 stations. The information was gathered only on boilers operating above 250 lb. pressure and containing over 10,000 sq.ft. of heating surface. Furthermore, only those units on which a report of ten months' continuous operation was received have been included in this report. This provision reduced the number of boilers reported to 186 from 50 stations.

Those persons filling in the log sheets were requested not only to report the normal boiler operation data, but

also to give the primary cause of each shut-down. From the data received the total outage for each unit was subdivided by the authors according to the causes reported. The results of this compilation are given in the report, both in tabulated and graphical form.

The calculations and conclusions are based on the following definitions, which were sent to the field with the log sheets:

1. A steaming unit is one that is passing steam to the line.

2. A banked unit is one in which the approximate line pressure is maintained with no flow of steam to the line.

3. A reserve unit is one that is cold, and in which the pressure is near zero, but which may be put on the line in the time it normally takes to lay and light the fire and bring the steam pressure to that of the line.

4. A crippled unit is one that is in such a condition that it is incapable of being put on the line within the time it normally takes to bring the boiler from cold to steaming.

Averages of various sorts were made from these calculations, and from them the authors conclude, in general, the results thus far deduced indicate that details of design and construction, and operating skill, are far more important in obtaining a high availability factor than are such things as rate of output per unit of surface, type of fuel, method of firing, and many of the other factors that have been widely discussed in this connection.

The availability factor is defined in this paper as the ratio between the sum of the hours during which the unit was steaming, banked, or available for service, to the total number of hours in the period.

The data collected indicate that boiler outage is not proportional to severity of use, and in fact seem to show a slight increase in availability with increase in severity of use. The authors believe it reasonable to assume that this is the result of more careful design and operation in the case of equipment that is driven at the higher rates.

From the reports, the authors estimated that part of the total crippled hours chargeable to the fuel-burning equipment and furnace. From these data and the total hours reported it was found that the highest availability was obtained for oil- and gas-fired units, slightly lower availability for pulverized-fuel-fired units, and lowest availability for stoker-fired units.

Some fairly definite indications were obtained that air preheaters on the average, decreased the availability factor by about 5 points. Plant operating pressures seemed to have little effect on the availability factor, except that a somewhat higher factor was indicated for the lowest pressure class. No conclusions could be drawn with respect to the age of equipment upon availability.

In presenting the paper the authors cautioned against using the data at their face values to reach definite conclusions.

Progress in Steam Power Engineering

THE trend in steam-power engineering is characterized in this report, contributed by the Power Division, of which F. M. Gibson is chairman of the executive committee, by the single word "magnitude." The year has witnessed larger mergers of invested capital, larger interconnections of central stations, larger industrial heating load, larger equipment, and larger demands for electrical power.

The most outstanding developments in boiler plant equipment are the rapidly increasing capacity and continuity of service of steam-generating units. There are in operation several units each having a maximum capacity of nearly 1,000,000 lb. of steam per hour, and one plant equipped with water-cooled walls and pulverized fuel firing operated eight months with no outage at time of demand. There has been an increase in the number of plants designed for steam pressures of approximately 1,400 lb., and in these plants there is a decided tendency toward straight-tube boilers.

F. M. GIBSON

Except for experimental purposes, there has been no trend toward higher steam temperatures, though there are indications that higher temperatures will be used in the near future. Manufacturers are prepared to build superheaters, turbines and piping for steam temperatures of 800 degrees.

With temperatures of 750 deg., practically all stations designed for pressures over 450 lb. are reheating. Single-stage reheating has been used in these stations, with the exception of two, where there has been installed a combination of steam and gas reheater.

In high-pressure stations the total heating surface of air preheaters, reheaters, bleeder heaters, water-cooled furnace walls and economizers, has increased until the actual boiler-heating surface is only 12 per cent of the steam-generating unit surface, and only 0.3 sq.ft. of boiler heating surface per kilowatt of plant capacity.

The trend of fuel firing in recently designed or constructed large stations is decidedly toward pulverized fuel. In the central station the bin system seems to predominate, while in the industrial field the unit system is favored. Pulverizing mills with a capacity of 25 tons per hour are now in operation.

In spite of this greater use of pulverized fuel, the underfeed stoker is impressive, and nearly every month of the present year has established a record in the number of retorts sold, that for August being 1,900. There are now available individual stoker units capable of producing 500,000 lb. of steam per hour, and one manufacturer has produced a ram capable of feeding 40 lb. of coal per stroke. Experience of the past year indicates that a gradual and complete redesign is taking place.

Feed water heating shows an apparent trend toward the more effective use of the regenerative cycle, four-stage heating being quite common, while in one station the feed water will be heated in as many as five stages. In one plant recently designed for 1400-lb. pressure the feed water is heated to 430 degrees.

During the year many large generating units have been placed in operation, the largest being a three-generator unit of 208,000-kw. One outstanding installation is a tandem-compound turbine with a single generator having a double winding with a capacity of 160,000 kw., and there is now on order a single generating unit of 115,000 kw. The trend toward higher pressures has resulted in the development of the steeple-compound unit, of which three have been purchased during the year. An indication of another possible development is the recent construction of a small turbine with a welded steel-plate casing.

Recently designed stations indicate a decided increase in the use of single-pass condensers, and the amount of condenser surface per kilowatt of turbine capacity shows a downward trend. There has been a more general use of condensers with tubes rolled in at both ends, and methods for taking care of expansion of tubes and shell. An outstanding development has been the installation of a welded steel-plate condenser of 27,000 sq.ft. surface serving a 30,000-kw. turbine generator.

In industrial plants advantage has been taken of higher steam pressures and high back-pressure and extraction-type turbines which deliver steam to process. There has also been a decided increase in substituting high back-pressure turbines for motors in power plant auxiliary drive, as well as in service equipment drives.

Exchange of power between central stations and industrial plants is gaining in favor. A number of plants report that this is working to the advantage of both parties. Also, in several instances, central stations have built plants to supply both steam for process and power to one or a number of industrial plants in the vicinity.

Discussion stressed the value of the reported data in providing for the first time a standard by which steam generating unit performance may be judged. Some surprise was expressed at the high boiler availability indicated, but one engineer felt a study of the performance of more recent installations would indicate that an availability equal to that of the turbine had already been reached.

Many questions were asked regarding the effect on availability of factors not included in the paper, and a general feeling existed that the work of collecting data should be continued in order that more definite conclusions might be reached.

Embrittlement in Steam Boilers

IN A paper on "Recent Instances of Embrittlement in Steam Boilers," Frederick G. Straub, of the University of Illinois, gives an account of several failures which, in his opinion, can be attributed to the weakening action of caustic on the steel plates. One of these occurred at Crossett, Ark., and the author shows that the typical embrittlement cracks that he found on examination were developed in a boiler operating with water having sodium-sulphate to-total-alkalinity ratio of 0.3, whereas the recommended A.S.M.E. ratio for the conditions there found is 2.0. The embrittlement is attributed to the results of soda-ash treatment on a boiler water too low in sulphate content.

Similar cases are cited from Virginia, Ohio, Michigan, Louisiana, New York, Colorado and Minnesota showing how a sodium-sulphate - to - total - alkalinity ratio below that recommended by the A.S.M.E. boiler code in each case was accompanied by failure due to typical embrittlement cracking. As these cases include boilers of many makes, operating under a wide variation in conditions, with nothing in common but a deficiency in sulphate content, it is indicated that attention must be given to this factor. It is also evident that waters not embrittling in nature may be readily made so by employing certain methods of water treatment.

Discussion of Mr. Straub's paper indicated that some think that too much weight has been given to the importance of embrittlement, that many failures by cracking arise from other causes and that embrittlement is frequently only a symptom. Many boiler failures have their origin in stresses set up by cold-working and in fabrication. These are more to be attributed to faulty design than to either poor material or incorrect boiler water control.

Attention was called to the effect of temperature differences in inducing failure. Such differences often result in stresses in excess of the yield point. Consequent failure cannot be attributed to embrittlement.

Soot Particles in New York City Air Discussed at Fuels Session

ASIDE from the progress report, the only paper presented at the Fuels Session was that on "Soot Particles in New York City Air," by Dr. E. E. Free, who has been engaged for some time in making dust counts chiefly at a station located on the seventh floor of a mid-town office building. The apparatus employed is a modification of the well-known Owens dust counter. Dr. Free's observations indicate considerable variability in the amount of soot, in which wind direction plays a large part. Seasonal variation is not large; in fact the maximum count was obtained in July 30, 1928, when 880,000 particles were found per cubic foot of air. Observations at street level showed a somewhat greater dust density. Rain appears to have little effect in clearing the atmosphere. The character of the particles as revealed by the microscope show about 90 per cent to be soot. Very litle ash was found.

The paper brought out considerable discussion in which was emphasized the need for continuous dust counts as related to light obstruction. Observations by the United States Weather Bureau in Central Park, with a Hill dust counter, showed results much lower than those reported by Dr. Free, but this discrepancy was attributed to the type of instrument used, which does not break up the aggregates. It was generally agreed that most of this soot comes from the large number of domestic and apartment house fires, which are not strictly seasonal, owing to the burning of rubbish, the heating of hot water, etc., during the non-heating season. As regards ultra-violet rays, it was agreed that these are not shown by the usual sun-light records; moreover, that while soot obscures these rays, cinders apparently do not.

Progress in Fuel Utilization

CONTRIBUTED by the Fuels Division, this report indicates a slow but consistent progression in the direction of greater efficiency and lower operating maintenance and capital charges. Of particular importance is the gradual adoption of more advanced methods by industries that until recently have shown little interest in fuel economy.

Production of bituminous coal during 1928 and the first nine months of 1929 was only slightly below the average for the five-year period 1924-28, but it is probable that the output for 1929 will be above that for 1928, owing to the general increase in industrial consumption, notwithstanding economies in use. For the first 224 days of each year the net outputs are 340,118,000 and 368,797,000 tons, respectively. Coal in storage had shown a uniform decrease. On July 1 stocks of bituminous coal in the hands of commercial consumers amounted to 33,100,000 net tons, the lowest amount reported since 1922. Price levels had been the lowest in thirteen years.

Anthracite production had about kept pace with that for 1928, the output up to Sept. 21 amounting to 52,193,000 net tons as compared with 52,388,000 tons in the corresponding period of the previous year.

Unprecedented activity in the coke-making industry is reported. Up to Aug. 1 coke to the amount of 40,232,537 net tons had been produced, as compared to 34,407,042 tons for the corresponding period in 1928.

In spite of efforts to curtail production of petroleum, the first seven months of 1929 showed an increase of 12.8 per cent over the corresponding period for 1928. For several years past and continuing during 1929, improvements have been made in petroleum production methods, resulting in appreciably greater recoveries. Perhaps the most interesting development in petroleum refining during the past year is the construction of a 5,000 bbl.-per-day hydrogenation plant, which is now under way, and the projected building of two others of equal size.

In the use of natural gas during the past year there has been an enormous increase, owing to the construction of long mains from the gas fields to various industrial centers.

Relative to manufactured gas: Data from 96 typical gas companies indicate for the first five months of the year over the same period for 1928 a 6 per cent decrease in water gas produced, a 12 per cent decrease in coal gas produced, a 39 per cent increase in coke-oven gas produced and a 22 per cent increase in coke-oven gas purchased from coke and steel companies. During these five months the total gas sold was 9.4 per cent higher in 1929 than in 1928, owing largely to the increased use of gas for house heating and industrial purposes.

Under low-temperature carbonization, reference is made to the 600-ton-per-day K.S.G. plant which in recent months has been placed in operation near New Brunswick, N. J., by the International Coal Carbonization Company. The semi-coke produced is being marketed locally as a domestic fuel, and the coal gas, mixed with blue gas, is sold to the Public Service Gas & Electric Corporation of New Jersey. A similar plant of 50 tons per day capacity is under construction at Coatesville, Pa. Since December, 1928, a "Lurgi" process plant having a capacity of 100 tons of briquettes per day has been in operation in Lehigh, N. D. It is adapted to North Dakota lignite and produces a carbonized-coal residue, which is briquetted with pitch obtained from the process.

Oil and Gas Engine Progress

The gas engine has been more or less ignored by the Oil and Gas Power Division. This year the only paper presented was on the gas engine, indicating a growing recognition of this fifty-million-dollar industry.

1929 History of the Diesel

SUBSTANTIAL advances have been made during the year in the design and application of internal-combustion engine, so E. G. Magdeburger stated in the progress report of the Oil and Gas Power Division.

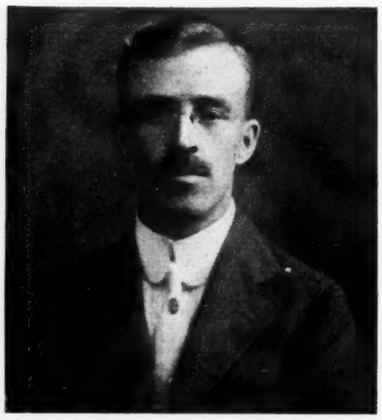
The year marked the completion of the second "Dieselization" program of the United States Shipping Board, so that now a total of 23 single-screw vessels constitutes the nucleus of the motorized American merchant marine. Eleven ships are equipped with double-acting engines, of which four are Worthington two-stroke-cycle four-cylinder units; four are powered with M.A.N. type two-stroke cycle four-cylinder engines; and the remaining three are of the McIntosh & Seymour four-stroke-cycle type, one four-cylinder and two five-cylinder units. Of the nine ships equipped with single-acting engines, six have Busch-Sulzer two-stroke-cycle six-cylinder engines, while three others have McIntosh & Seymour four-stroke-cycle six-cylinder engines.

The three remaining conversions finished during the year are electric-drive ships with four 1,280-hp. eight-cylinder 250-r.p.m. trunk-piston McIntosh & Seymour engines driving electric generators, with a single propelling motor of 4,000 horsepower at 60 r.p.m.

Private enterprise in the United States has been responsible for only one larger motorship, a freight and passenger ship for the American and South African Line, in which two 2,700-hp., 95-r.p.m., four-cylinder, Sun-Doxford two-stroke-cycle, opposed-piston engines of 21.26 in. bore and 85.04 in. combined stroke constitute the propelling plant.

A total of 105 oil-electric locomotives were in service or on order in the United States and Canada by Sept. 1, 46 of which were ordered during the year, as well as 35 switching locomotives ordered at one time by New York Central for its New York west side yards. These latter, in addition to the standard 300-b.hp. Ingersoll-Rand engine, have a 219-cell, 17-ton Exide battery and are arranged to operate also with outside current, either through third rail or from an overhead collector.

The Canadian National Railways has recently put into commission a large articulated locomotive, housing in each cab one twelve-cylinder V-type Beardmore four-cycle engine rated at 1,340 hp. at 800 r.p.m.



E. G. MAGDEBURGER

The progress in the art of oil-engine building owes much to the perfection of the materials available for construction. The introduction of "nitralloy" steels having a glass-hard surface with a tough core has opened new possibilities for crankshafts, cams, pump plungers, and gears. Chromium plating was used in the Worthington engines for the Shipping Board, to produce a hard-rubbing surface on a piston rod without affecting the elasticity necessary to withstand explosion shocks. The extension of this process to cylinder liners is being perfected, and the building up of worn parts of plungers, valve stems, etc., may prove to be valuable for quick repairs.

Spray research continues at the N.A.C.A. laboratories at Langley Field, at Penn State College, and at the A.E.G. laboratories in Berlin.

The distribution of natural gas requires much power in gas-driven gas compressors. For the large pipe line from Louisiana to St. Louis twelve Worthington 1,000-b.hp. units were installed during the year. The largest byproduct source of energy is blast-furnace gas, and the Bethlehem Steel Company reports the installation of five of its 47 x 60-in. tandem double-acting blowing engines. During the year the Allis-Chalmers Manufacturing Company designed and built two of its largest twin-tandem gas engines, with 60 x 64-in. cylinders, to be operated on blast-furnace gas. The first plant in this country to be run successfully on sewage gas consisted of Sterling gasoline engines in Charlotte, N. C.

The Gas Engine in the Oil Field

IN his paper on "The Gas Engine in the Oil Field," George L. Reid pointed out that there were 150,000 gas engines in oil-field work in this country, to which number about 15,000 engines are being added yearly.

The single-cylinder horizontal gas engine has been the chief dependence of the oil man, due to its simplicity and flexibility. The vertical multi-cylinder has so far not won a place in oil production lines.

The builders of four-stroke-cycle engines have found it necessary to sacrifice some of the possible fuel economy to obtain ease of maintenance. The compression pressure and the positions of the inlet and exhaust valves have increased the fuel consumption but have been necessary. The engines employ an inclosed bedplate. This requires a separate combustion head so that the piston can be renewed readily, and to do this easily the valve passages have been kept within the cylinder casting, which pockets lessen the compression it is possible to carry.

The two-stroke-cycle gas engine is installed in greater number than any other type. These are developments from the original Clerk engine, which employed a separate charging cylinder. The first Clerk engine to be applied to oil-field use was built in Oil City, Pa., in 1893. This type of engine is still widely used.

Other designs include the use of the crankcase or the rear of the cylinder for the pumping cylinder, but the efficiency of such engines is not high compared to the pumping-cylinder engine. Following the trend in automobile practice, the ratio of bore to stroke is less than formerly. Bearings have been increased, and roller bearings are coming itno use but cannot be considered a standardized part. Speeds of these single-cylinder engines have raised from 180 to 450 r.p.m. This has necessitated the lightening of the reciprocating parts, and in one case pressure oiling of the bearings has permitted speeds up to 500 r.p.m. without pounding.

The author devoted considerable space to a discussion of the various kinds of machinery used in oil-field work. He stated that so far mechanical engineering has failed to improve designs, which are still based on rule of thumb.

Clarification of Lubricating Oil

IN a paper on "Service Characteristics of Diesel Lubricating Oil," A. E. Flowers and M. A. Dietrick, of the De Laval Separator Company, discussed a series of tests run on a 300-hp. 550-r.p.m. 10 x 12-in. six-cylinder solid-injection type of engine operating a locomotive.

The test revealed that service tends to increase the gravity, the fire- and pour-points, the viscosity and the carbon residue. The neutralization point is also increased, while the flash-point decreases slightly, due to cracking of the oil.

These charges are controlled by the amount of make-up oil added, but fuel dilution is predominant as the controlling factor. The fuel dilution is due in part to direct leakage past the piston rings but occurs usually when a cylinder fails to fire. It was found that some oxidation occurs, not through a defect in the oil but as a result of the necessarily severe service.

It was found that when the sludge is received at the same rate it is produced, the sludge percentage after adding make-up oil, rises during the first part of the next run until it stabilizes at a moderate value. Usually the sludge does not exceed 2 per cent by volume of the oil and is mainly carbonaceous matter. From a new engine, however, large amounts of metal fillings and sand may be found in the oil.

The authors found that there is no reason why crankcases should be drained of oil, providing clarifications is carried on continuously. Continuous clarification saves some oil, but its chief advantage is the reduction in bearing wear. Tests show that washing the oil with clean boiling water before centrifuging allows through-put rates about 100 times greater than when washing is not employed. Apparently, clarification restores all the oil properties except color. The fuel oil dilution may be removed by heating and blowing steam directly into the oil.

Basic International Tables Made Public at Steam Research Session

THE eagerly awaited basic international steam tables were made public at the steam-table research session on Wednesday afternoon. Harvey N. Davis, president of Stevens Institute and long a leader in steam-table development, summarized to the assembled specialists the official report of the July meeting in London at which leading steam research workers of America, Great Britain, Germany and Czechoslovakia agreed upon a set of values and tolerances. The nature and accomplishments of this conference were outlined in *Power* in the Sept. 3 ,1929, issue, but no information as to actual values was available before this meeting. An abstract of the report, with values, will appear in *Power* shortly.

The skeleton table of values and tolerances was laid out at the conference and subsequently checked and approved by all the participants. It was agreed that any table that meets the specified values within the specified tolerances is officially entitled to the label "international." The skeleton tables, in metric units throughout, cover both saturated and superheated steam. For saturated steam, pressure, specific volume of liquid and vapor, heat of the liquid and total heat are given over the temperature range from zero to 350 deg. C. in steps of 50 deg. For superheated steam specific volumes and total heats are given for pressures of 1, 5, 10, 25, 50, 100, 150, 200 and 250 kilograms per square centimeter, and for temperatures running up to 550 deg. C. in steps of 50 deg.

Attention was directed to another accomplishment of the conference, perhaps even more significant than the development of a basic skeleton steam table. It was pointed out that the agreement to define the heat unit in terms of electrical energy wipes out at one stroke all the errors due to, and future changes caused by, uncertainty as to the value of the mechanical equivalent of heat. By unanimous agreement a kilocalorie is now exactly equal to 1/860 kilowatt-hour.

Summarizing the report, Dr. Davis said that the steam research conference in Berlin next June, will consist, as was the case last summer, of individual experts not appearing as representatives of any country. The skeleton table, he pointed out, will tend to concentrate the attention of research workers on those regions where the tolerances are largest, and will lead to a gradual "closing in" over a period of years.

Arthur M. Greene, Jr., dean of the Engineering School at Princeton, presided. At his side sat George A. Orrok, chief sponsor of the steam research programs that have been under way for some years at Harvard, M.I.T. and the Bureau of Standards. These institutions were represented through papers presented by F. G. Keyes and L. B. Smith (M.I.T.), N. S. Osborne (Bureau of Standards) and Dr. Davis (formerly of Harvard).

Professor Keenan, of Stevens Institute, compared the values given in his new steam tables (to be published shortly) with those obtained by various investigators and also with those in the international skeleton table. With a few exceptions, he agreed with the latter within the specified tolerances.

Working Stresses at High Temperatures

IN A paper on "Working Stresses for Steel at High Temperatures," D. S. Jacobus of Babcock & Wilcox Company, reviews the work done by numerous investigators in determining the creep point for various steels subjected to stress at elevated temperatures.

These working stresses have been determined from practical experience and have proved suitable in use. For instance, Babcock & Wilcox Company some years ago built several oil stills to operate at 825 deg. F. The working stress was selected for these from experience. Now it is apparent that this stress is a safe figure, at two-thirds the creep-point stress. Working stresses for this particular metal at higher temperatures can be established by scaling down from this value in proportion to the falling off of the creep-point stress, or taking a value of two-thirds of this stress.

Results obtained by Professor Norton, of M.I.T., are cited, which indicate that a stress of two-thirds that required to produce 1 per cent of creep in 10,000 hr. would be equivalent to 80 or 90 per cent of the stress required to produce a rate of creep of 1 per cent in 100,000 hr., and that the stress would correspond to 1 per cent of elongation due to creep in 25 to 60 years. These figures are not given as absolute values but to show that a reduction in stress below that required to produce 1 per cent creep in 100,000 hr. has a marked effect in increasing the time for a given amount of creep.

Recommended Rule

Tentatively, Dr. Jacobus gives the following rule:

For the higher temperatures, where the steel is distinctly plastic, use two-thirds of the stress required to produce a rate of creep not to exceed 1 per cent in 100,000 hr. In case of doubt, use the stress corresponding to a lower rate of creep, in view of the many uncertain elements.

For the lower temperatures, use the same working stress as at ordinary room temperatures, provided the ultimate strength determined by a quick-time test at the particular temperature divided by the factor of safety is as great as the working stress for ordinary room temperatures and also provided the stress does not exceed two-thirds of that at the creep point.

In discussion of Dr. Jacobus' paper several speakers emphasized the service he had done in publishing actual figures used by his company, thus encouraging others to do likewise. The need for improved and standard creep test methods was pointed out, for tests so far available show such wide variation in values obtained that they can only be used with extreme caution. However, it was stated that the values in the paper seem to be close to a minimum and therefore should be safe for use until more data are developed.

Hydraulic Sessions Feature Power Development

Five papers and a progress report covered a wide range of subjects, including the economic relation between hydro- and steam-plant capacity; increased kilowatt-hour output possible with adjustable-blade propeller-type turbines; vibration in penstocks; changing conditions in waterwheel regulation, and the mechanics of speed regulation.

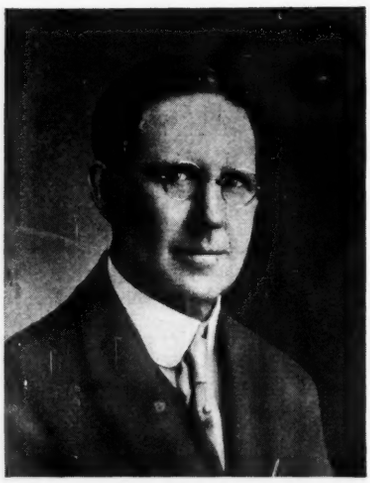
Relation Between Steam and Hydro

IN A paper entitled "Steam or Hydro, or Both," William W. Tefft presented an analysis of the proportions of hydro and steam capacity to obtain the most economical combination. The opinion was expressed that, in general, it has been shown and described conclusively in the technical press that the cost of power in a combined system is less than it would be if the total power were supplied by either steam or water power.

Mr. Tefft based his statements on a checking list that he gave for the comparison of steam and hydro plants. It is his opinion that while the first cost of steam per kilowatt is usually less than for hydro, the operating charges tend to equalize them, so that the summation when considered on the basis of annual kilowatt-hours may show little difference. The increase in steam-plant efficiency is seen to have the effect of increasing the percentage of fixed charges on these plants, due to an increased rate of obsolescence. The present economic life of a steam turbine is 5.5 working years. The depreciation and obsolescence item for steam plants is given as at least 10 per cent, whereas for the permanent high-efficiency hydro plant 2 per cent is ample. This would make the total annual fixed charges for hydro 10 per cent and for steam 18 per cent.

Considerable stress was placed on the effects of load factor. Curves show that at about 65 per cent load factor, the cost of power at the switchboard is about the same, 6.5 mills per kilowatt-hour for either type of plant. At 30 per cent load factor the cost of hydro is less than 8 mills per kilowatt-hour, while the cost of steam is 11 mills per kilowatt-hour.

The conclusion was drawn that there is ample proof that a power system combining both steam and hydro plants can generate power more cheaply than either type of prime mover for the same conditions. Throughout the country steam power is being developed about three times as fast as hydro power, mainly because this appears to be somewhere near the proper ratio of steam and hydro. In the future, steam plant efficiencies will increase but the cost of obtaining this will increase also, and it would seem that the prospects of hydro continuing to maintain this percentage of development is still bright.



WILLIAM M. WHITE
Chairman of the Hydraulic Division

The discussion on Mr. Tefft's paper was very much in agreement with his findings that a given power load can be supplied more cheaply with a combination of steam and hydro plants than by either alone. Joel D. Justin in his remarks sized up the situation by saying: "As a result of many investigations, I am convinced that in any section of the country where suitable hydro sites exist, the load curve of a large power company can be more economically supplied by a suitable combination of hydro and steam plants than by steam alone. It is unfortunate that these two sources of power are usually considered as competitive. This is only in a very limited sense. Their relationship can be better expressed by saying that they are complementary."

A ten per cent per year obsolescence and depreciation as given in Mr. Tefft's paper was not considered proper against steam plants. It is only relatively true to say that a steam plant ten years old is obsolete. Such a plant still has earning capacity, but its function is altered.

Propeller-Type Waterwheels

BY ADJUSTING the blades of propeller-type turbines for changes in load and head, high efficiency can be maintained over a wide load range. This was discussed by C. R. Martin in a paper "Increased Kilowatt Output of Adjustable-Blade Propeller Turbines." The objectionable feature of the fixed blade type of propeller runner is the peak efficiency curve and the low efficiency at part gate. By adjusting the runner blades it can operate at all the peak points of efficiency, thus reducing the disadvantages of part gate operation.

The author stated that it is now possible to obtain a peak efficiency with a propeller-type runner that is within 1 or 2 per cent of the peak efficiency of a Francis-type runner.

As an example of what may be accomplished with adjustable propeller-type runners in low-head plants, attention was called to a plant consisting of three 1,200-hp. units operating under a 9-ft. head. In this plant the original units were vertical Francis runners connected by gears to horizontal-shaft generators, the output from which averaged 8,000,000 kw.-hr. per year. The output from the adjustable-blade propeller units, that were set in the same over-all width of the power house and used the same volume of water as the original machine, has exceeded 12,000,000 kw.-hr. per year. The increased output is attributed to a greater installed capacity and a higher over-all efficiency.

A great deal of interest was centered in the adjustable-blade propeller-type runners. Much of the discussion was on the relative merits of the type which has its blades adjusted manually after the unit has been stopped, and the type that has its blades adjusted automatically from the speed governor. Both are now being manufactured in this country and are coming into wide use. The difference in cost of automatic adjustment over manual adjustment was placed at about 6 per cent. This difference increases somewhat with the smaller sizes and decreases with the larger sizes. The trend of the discus-

sion leads to the conclusion that there is a field for both classes of adjustable-blade runners.

Mechanical Vibration in Penstocks

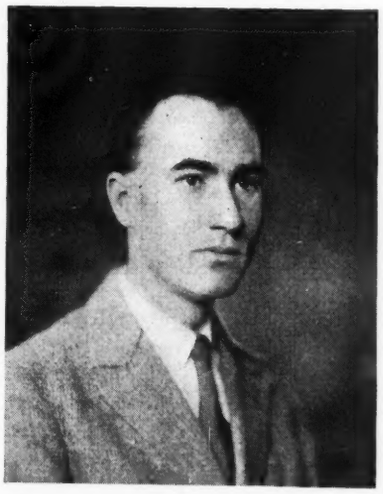
SERIOUS VIBRATION has been experienced in power houses and penstocks where Francis-type water wheels are installed. A theory for this phenomena was given by J. P. Den Hartog, in his paper "Mechanical Vibration in Penstocks of Hydraulic Turbine Installations." This vibration is attributed to the action of the runner buckets upon the streams of water entering the wheel from between the guide vanes. Impulses set up in the stream under certain conditions are transmitted back into the penstock. Objectionable impulses, according to the theory, are produced when the number of buckets in the runner is one less than the number of guide vanes. Satisfactory operation should be obtained when this relation is avoided by making the number of buckets equal to, or two less than, the number of guide vanes.

The discussion on the causes of vibration, although agreeing that the author of the paper had made a valuable contribution to the art, did not agree that making the runner with one bucket less than the number of guide vanes was always the cause of vibration. Machines with this combination have worked satisfactorily for years. The size of the unit, the clearance between the buckets and guide vanes, the rigidity of the penstock, the condition of the seal rings and other features are also factors in the problem. Attention was called to one instance where vibration was cured by increasing the clearance between the buckets and guide vanes. Curing the trouble also increased the efficiency of the unit.

Hydraulic-Turbine Speed Regulation

"CHANGING Requirements in Hydraulic-Turbine Speed Regulation" was the subject of a paper by Forrest Nagler. Flyball governor control of units such as are now operated in the plants of large systems may be of secondary importance for normal conditions. These governors, the author pointed out, are frequently quite foreign in their action to the main purpose of the plant in which they are installed, being one of the major causes, if not the major cause, of loss of kilowatt-hour output, interruptions to service, damages to parts and increased maintenance costs. Conventional governor action is a relic of requirements that no longer exist, as there is no necessity for extensive and continuous gate movement, on large units, to effect speed control.

It was suggested that practically complete governing equipment can be built without a large flyball and with probable simplification of governing equipment. It would consist of a frequency control operating the gates through regulating cylinders and distributing valves, a load limit positioning device for that valve, just as is now done, except that no main relay connections would be required, no dashpot being necessary and all questions of flyball drive being eliminated. Emergency stops and emergency starts would be obtained simply by making secondary contact at an abnormally high or low frequency that would take the unit off the line or at least close its gate to speed-no-load conditions.



J. P. DEN HARTOG

It is not recommended that governors be eliminated, as many of their elements are satisfactory. The oil-pressure systems now in use are probably the best form of speed-reducing mechanisms for the purpose.

Under the title "Mechanics of Hydraulic Turbine Pressure Regulation," Arnold Pfau presented an analysis of speed and pressure control of hydraulic turbines. Problems of pressure control or the pressure resulting from governor action complicate the calculations of hydraulic turbines. A mechanical means was described whereby the desired field result can be obtained under existing conditions of operation and pipeline characteristics. Calculations, formulas and examples of speed and pressure control take up such points as closing the gates, passing through the position of static balance of the turbine gates, formulas for speed regulation, effects of pressure variation on speed, and calculations of pressure rise in pipe lines.

Much of the discussion at the afternoon session was on the value of a governor on hydro-electric units operating on the modern large power system. On this point there is a wide divergence of opinion. The large increase during recent years in power-system capacity that has resulted from interconnection and increased size of plants, has changed the whole aspect of speed regulation of hydro-electric units on the system. It is generally agreed that the governor should be retained, if for no other reason than that a large part of the present speed-regulating equipment would be required to open and close the gates even if done manually. That being true, at small additional expense automatic governor control can be made available.

Although, in hydro plants operating on a base load, the flyballs of the governor control could be dispensed with, plants operating on peak loads require a governor that will make the units pick up the load in the shortest time. On a number of the large systems, governors are used on the units for their usual functions, such as synchronizing, dividing the load between units, speed regulations, etc., and the frequency of the system controlled by a super-sensitive device. By such a combination the frequency of the system can be maintained to within a high degree of accuracy without a sacrifice in efficiency.

Progress Report

THE progress report of the Hydraulic Division, by Byron E. White, chairman of the committee, covered a variety of subjects that embrace practically the whole field of water power development. Attention was called to the effect of consolidation of electrical companies into fewer and larger organizations. These effects have been both favorable and unfavorable to water power development. The larger interconnected systems have created a much larger power market to be supplied, but they have also made possible larger and more economical fuel-burning stations. These have lowered the unit cost of energy to a level where many water power stations can no longer compete. It was suggested that a partial solution of the difficulty may possibly be found in a simplification of hydro-electric construction that may result in lower development and operating costs.

The report did not favorably consider the increasing tendency to purchase hydraulic equipment on the basis of price alone, and stated:

"It hardly seems necessary to call to the attention of engineers that there is still room for advance in design and construction, which can be brought about only by continued study and experiment, at someone's cost. In this field, the logical source of such experimentation is the manufacturer. Price-cutting below the level of a fair profit will inevitably dry up the springs from which improvements flow."

There is also reported a marked increasing tendency among power companies to have their units tested for efficiency under operating conditions and to rate some hydraulic section adjacent to each unit for use in connection with a flow recorder. The opinion was expressed that the value of records in checking station performance, as well as in planning future development, is hard to overestimate.

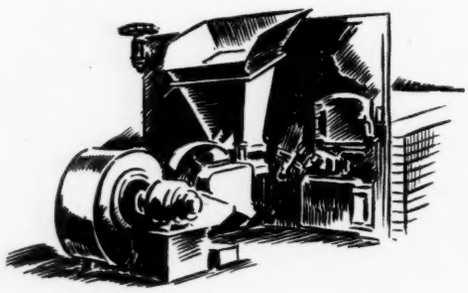
What One Saw at th

ALTHOUGH not quite so large or extensive as some of its predecessors, the Eighth National Exposition of Power and Mechanical Engineering held last week at the Grand Central Palace, New York City, was an improvement on some of the previous shows, if the comments one heard on every hand were to be taken seriously.

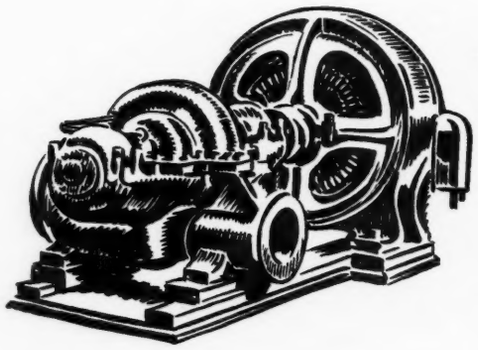
Every exposition carries its undertone of comments of exhibitors and visitors that, in the aggregate, tells the story of success or failure—the consensus of opinion, as gleaned from these remarks was that this year's show was a nearer approach to a real power show. It was also apparent from these comments that the decrease in the number of miscellaneous exhibits of equipment irrevelant to the power field, which so characterized last year's show, was generally appreciated. The decrease in the number of these exhibits not only tended to make the show more nearly what it was planned to be originally, but also helped to conserve the visitor's time and make his trip through the exposition a more profitable one.

It is true that several of the larger manufacturers of power plant equipment were not included among this year's exhibitors; nevertheless there was a sufficient number representing each important line of equipment to indicate the present trend or development in each line.

As in previous years, an important feature of the show was the introduction of new equipment in the various lines. Much of the new equipment that was shown for the first time has been previously illustrated and described in the "What's New in Plant Equipment" section of *Power*. No attempt will be made in this brief review of the exposition to describe any particular piece of new equipment in detail, as this will be done in the early issues of *Power;* instead some of the important general aspects of the exposition will be given.



In fuel-burning equipment the number of stokers shown outnumbered the pulverized-coal or oil-burning apparatus. The stokers ranged in sizes from the smallest commercial sizes up to units suitable for boilers of 5,000 sq.ft. of heating surface. Many of the units were of the single-retort side-dump type applicable to the smaller installations and for replacing hand-firing in heating plants. One manufacturer showed a complete self-contained stoker unit in which the motor with direct-connected forced-draft fan is in front of the stoker and the motor drives the stoker through a variable speed mechanism that gives a coal-feed range between 60 and 6,000 lb. of coal per hour. A recent addition to this unit is an automatic control that regulates both the coal feed and air supply and maintains a definite ratio between the two at all loads. Improvements and refinements on another unit shown included simplified and more compact damper control, motor and gear-reduction unit, and coal-feed adjustment.



Improved Design of Pulverizing Mill

A new design of pulverizing element shown by one of the larger manufacturers was the principal exhibit of this type of coal-preparation equipment. The new element consists of an upper and lower stationary ball race or grinding ring, with an intermediate or central revolving ring and two rows of balls. The balls are in contact with the stationary and revolving rings as well as in contact with each other, giving three points of contact. Another feature of this construction is that all the thrust of the grinding element is removed from the shaft and is carried by the grinding balls themselves, the center revolving ring being free to float on the vertical shaft. The pressure between the rings and the balls is adjustable from the top of the mill. This type of unit is being built at present in capacities up to 25 tons of coal an hour.

A recent improvement made to another pulverizer seen at the show is the use of a steel band in the form of a horse shoe, separate from the casing proper, to which is bolted ribbed castings that not only take the wear but have an important part in the pulverizing process.

A large combination oil and gas burner, now being built in unit capacities suitable for boilers evaporating from 45,000 to 75,000 lb. of water an hour was the principal exhibit in this class of equipment. The unit is designed for such capacities burning either oil or natural gas and is said to give high efficiencies with extremely low forced-draft pressure. It operates equally well with either steam or mechanical atomizing oil burners.

A recent development in boiler practice was exemplified in a section of arc-welded boiler drum 42 in. inside

diameter and of 2-in. thick plate, shown by one manufacturer. The section was cut from a test shell that withstood over 1,035,000 applications of pressure at 1,570 lb. per square inch (1½ times the working pressure) with no evidence of failure in the weld. This manufacturer also showed an economizer section having forged return bends at one end and hairpin bends at the other, and also a superheater section of the latest design multiple-loop unit. In this design each section is flexibly supported independently, but the loops or runs of tubes are supported rigidly in relation to one another. The outer loop is a complete U-bend, but the inner loop or the one toward the header is extended into a single opening and closed with a plug. This opening is provided to facilitate cleaning of the tubes. A part of this exhibit that attracted a great deal of attention was a sectional model of a cross-drum boiler with superheater, air heater, economizer and armored furnace wall, equipped with a link-grate underfeed stoker. The model is ⅛ actual size, stands 10 ft. high and will be part of a permanent exhibit presented to the Smithsonian Institution at Washington, D. C.

Armored- and Bare-Tube Water Walls Exhibited

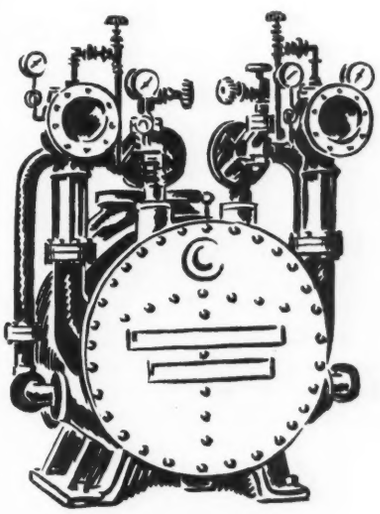
Water- and air-cooled furnace walls and refractories were fairly well represented. The water walls included both armored- and bare-tube types and indicated the latest development in this particular field. The exhibit of refractories featured, principally, high-temperature cements and bonding materials. The new cements were claimed to be chemically neutral and particularly resistent to penetration by basic slags.

Of particular interest to those confronted with the problem of taking care of the fly ash discharged up the stack from powdered-coal furnaces was a working model of a dust trap especially designed for this service. This unit is placed between the boiler outlet and the stack, preferably ahead of the induced-draft fan. The gas passes through it in a horizontal direction and the dust is collected in hoppers at the bottom. The dust-collecting units consist of a series of barbed and corrugated plates suspended vertically about ⅜ in. apart. The plates form alternately a nozzle and expansion chamber and the dust in passing through the machine is blasted against the plates, to which it adheres through intimate contact and electrostatic attraction. The plates are cleaned by an automatic rapping device that lifts each plate about ½ in. and drops it. The jar loosens the dust and it falls to a hopper at the bottom.

A new development in soot cleaners was an automatic valved soot blower head for use with air instead of steam and especially designed to give a minimum of pressure drop through the element.

One of the principal disadvantages of ash-sluicing systems, that of inefficient pumping units as a result of the abrasive-laden water handled, would appear to be overcome in a new type of pump introduced at the show. This new pump, which is built in both vertical and horizontal motor-driven types, is equipped with a main and an auxiliary impeller fitted side by side on a common shaft but with separate volutes or discharge chambers. The auxiliary impeller, which is designed for a high head, is fed by an independent clear-water supply. This water, in turn, is discharged into an auxiliary volute chamber, where it is converted into pressure energy and, finally, discharged into the main volute through the clearance spaces at the periphery of the main impeller. This flow of water through these clearance spaces tends to keep them clear of ash or abrasive particles and makes it possible to run the main impeller with a minimum of clearance, which heretofore has not been found practical. The clearances in this pump are adjusted to 0.002 in., which compares favorably with high-efficiency pumps designed for clear-water service.

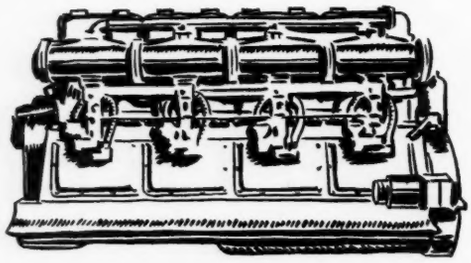
That the scientific treatment of boiler water is now receiving its share of attention was evidenced by the interest shown in the exhibits of chemical-proportioning and acid-feeding equipment exhibited. In one type of acid feeder shown, air pressure is transmitted to the surface of an acid solution and causes the acid to be discharged through an orifice at a rate proportional to the flow of raw water. This system is particularly suitable for the treatment of boiler feed water with acid to correct excessive alkalinity or for the purpose of increasing the ratio of sulphate radical to the caustic alkalinity to avoid embrittlement of the boiler steel. It is also adaptable to the feeding of reagents in various industrial processes.



Another unit shown in actual operation was an electromagnetic proportioner for a water softener. The proportioner is mounted on the top of the chemical tank, and the amount of water supplied to the tank controls the volume of chemicals introduced, so that a fixed ratio is maintained. The water is measured by a standard meter, to one shaft of which is fixed two cams that open and close electric contacts. The contacts, in turn, supply

current to a solenoid-actuated ratchet device that functions to control the amount of chemical fed in direct proportion to the flow of water through the meter.

As has been characteristic of other shows, the absence of prime movers was noticeable. With the exception of a couple of small steam turbines, the only prime movers shown were three gasoline engines. The largest of these was an eight-cylinder, with an 8-in. bore and a 9-in. stroke and a horsepower rating of 565 at 1,200 r.p.m.



The engine is fitted with four carburetors, each supplying fuel to two cylinders.

The demand for instruments for giving remote indications and records of liquid levels, rates of flow, pressure, temperature, drafts, etc., would appear to be well met by the various manufacturers. The use of Selsyn motors for this purpose is becoming quite general, and a number of new devices employing this method were shown. One company has utilized it in the long distance indicating and recording devices that are now being used to transmit indications and records over distances varying from a few feet up to several miles. Another company has applied it to a Venturi meter, so that the instrument may be placed close to the Venturi tube and an indicator or recorder placed in the engineer's office or at any other remote point.

Flow Meters Now Available for High Pressures

Other new instruments found at the show included a high-pressure flow meter manometer good for 1,500 lb., new dial-type air filter gage to show the differential pressure across the filter, and several new lines of flush-type indicating and recording instruments.

With the increasing uses of high pressures in power and industrial plants, one of the most important pieces of equipment is the high-pressure valve, with its various methods of operation and control. One company included in its exhibit three valves with three distinct types of control. These are electric, air and hydraulically operated and are designed to cover a wide range of application. This company also exhibited a new design of boiler stop and check valve with toggle operation on the valve spindle.

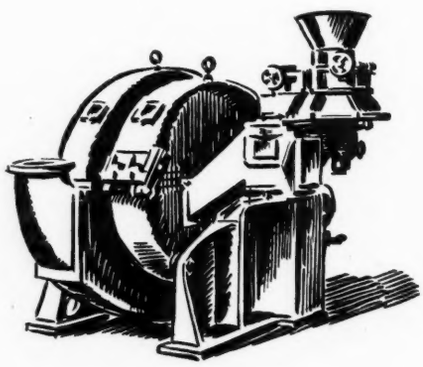
The principal feature of the piping exhibit was a hammer-welded header with one end and four side outlets. The header was 24 in. in diameter, with $1\frac{1}{2}$-in. wall thickness and suitable for 450 lb. working pressure.

One of the most recent developments in pipe-line expansion joints shown was a double-type cylinder-guided expansion joint fitted with a chromium-plated steel sliding sleeve. The joint is fitted with an unusually deep stuffing box and has internal limit stops.

The engineer particularly interested in heating equipment found much of interest and value at the show. The design of air heaters has become more or less standardized, but an important accessory, the unit heater control, is now in course of development, and some units for this purpose were shown. A dual control combines two instruments in one, automatic control of room temperature by starting and stopping the fan motors and an automatic cut-off that stops the motor or prevents it from starting as long as the heating surface is cold. The control, which is attached to the side of the heater, consists, essentially, of two thermostatic elements each operating the same mercoid switch.

An automatic radiator valve that is essentially a thermostatic valve for controlling room temperature; auxiliary actuated controlling equipment for either reducing pressures or for relieving pressures; solenoid-magnet-operated valves; a new electric-convection-type radiator; a line of bronze globe and needle valves; a new line of balanced reducing valves for extra-sensitive regulation of low-pressure steam or gas; and an air-operated indicating mercury controller—were among the many heating and process-steam controlling devices found at the show.

A feature of the show that always stands out is the electrical equipment, not so much for the number of individual exhibits but on account of the prominent part electricity takes in practically every exhibit. An interesting example of how light may be used was in a silent-



chain drive display. By the application of neon light, the chain, when running 600 ft. per min., could be made to appear as running very slowly. Then, by looking through a large reading glass, an enlarged view of the chain was obtained as it passed around the sprocket. This gave an opportunity to study the action of its joints.

In another instance, three banks of lights were used to demonstrate the action occurring when starting a three-phase squirrel-cage motor with a carbon-pile type resistor and with a compensator-type starter. It was demonstrated that with the carbon resistor the voltage was gradually increased from practically zero at the motor terminals to nearly full value before connecting it to the line. This was shown by the gradual increase in the lamps' brilliancy. When starting with the compensator, the lamps lighted up to nearly full on the first application of voltage to their terminals. On shifting from partial to full voltage the lamps went dark and then to full brilliancy. This is characteristic of the compensator type of starter. At the instant of starting a

large percentage of full voltage is applied to the motor. Then, to apply full voltage, the motor is first disconnected from the line and then thrown directly across the supply circuit.

Of the electrical equipment exhibited, an outstanding example was a system of automatic frequency control. This system is applied in two forms: One, where the generators are all of the same capacity and have like characteristics. In this application the system of frequency control will maintain equal loading between the generators. The second form of this equipment is for use when the machines are not of like characteristics. In that case the control will divide the load between the generators to obtain the best over-all station efficiency.

In addition to dividing the load between the machines, the frequency is maintained automatically within a small part of 1 per cent of its correct value. In the application of this system of frequency control the governors perform the same function as they always did and the frequency control corrects the error due to the drooping characteristic of the governors. In other words, the system of automatic frequency control does the same thing that the operator would do; namely, if the frequency is off a little due to change in the system load or other causes, it adjusts the governors to correct the speed of the machines.

Another interesting exhibit was a system of synchronous selector supervisory control. This system not only allows controlling machines from a distant point, but the equipment's operation can be checked by the operator, meter reading obtained, switch positions determined and other information had that is available to an operator in the plant. The substations for the new municipal subway system of New York City will be so controlled.

The many instrument and control switches required for the operation of a large plant necessitates a very large switchboard to accommodate them, if they are of the conventional size and are arranged in the usual manner. A system of miniature switches and meters was on exhibition that allowed concentrating the common type of switchboard into a space a few feet square, so that the entire control of the plant is within easy reach of the operator.

A full-size oil-immersed switching unit, including the busbars, cable connectors and current transformers, was exhibited. This unit illustrated the trend in present-day high-voltage switching equipment. In this unit the disconnect switches, busbars, current transformers and cable leads from the pot-head to the busbars are inclosed in oil-filled containers. This arrangement not only insures greater reliability, but also reduces the space required for installation.

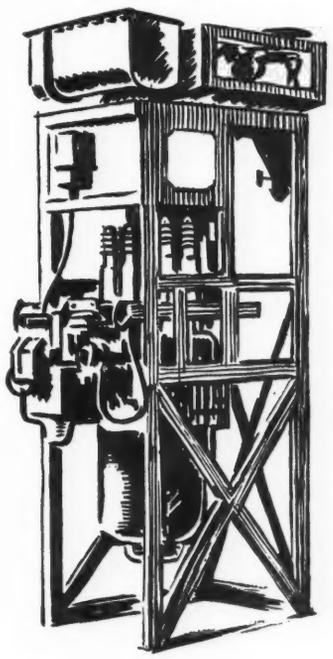
Another trend noticeable at the show was the reduction in size of motor-control equipment. Starting equipment that used to be large and cumbersome is now available in sizes that go within the limits of the ordinary junction box. One exhibit of this kind was of a push-button starter with thermal overload protection for a $\frac{1}{2}$-hp. 110-volt motor. The entire equipment was inclosed in a metal box having the dimensions of the ordinary lighting push-button switch box. A $\frac{3}{4}$-hp. 220-volt starter with thermal overload protection occupied the space of a square eight knock-out junction box. Control equipment like this solves the problem of finding space for mounting on a machine.

Where it is desired to control a motor or other device from a number of points, the usual practice has been to place push-buttons at convenient locations. A cable was shown that made possible controlling equipment from practically an unlimited number of stations. By pressing the cable at any point, contact is made to operate the control.

A new and unusual electrical application was a heat-flow meter operated by thermocouples placed around the object from which the heat flow is to be measured. An instrument connected to the thermocouples gives a direct reading of the heat loss in B.t.u.'s per hour, per square foot of heat-dissipating surface.

At one time it was generally thought that the electric motor would make mechanical power-transmission equipment something of the past. However, this idea was very much out of line with what has happened. The ever-increasing requirements of industrial power application have expanded the demands for speed ranges and adjustment beyond anything formerly thought of, with the result that the mechanical power-transmission equipment field is larger today than ever before. True, it is of a different character than that used before the days of electric-motor supremacy, but it is nevertheless mechanical power-transmission equipment. One of the largest groups of exhibitors at the show was for this class of machinery. Short-center belt drives, multiple V-belts, gear-type speed reducers, variable-speed transmissions, silent-chain drives, clutches, flexible couplings and many other classes of this apparatus were displayed and demonstrated.

The wide range of service conditions for which this equipment is made is astounding. For example one manufacturer exhibited a gear speed reducer as standard equipment with a ratio of 1,450 to 1. Another booth showed a reducer that had a ratio of 100 to 1 in a single reduction. Variable-speed transmissions were in evidence in a wide variety of forms. Some allowed adjusting the speed of the output shaft from zero up to near that of the driving medium. Other types adjusted the speed between given value and were provided with push-button control. Other exhibits showed complete power units combining a motor with a speed reducer or a motor with a speed reducer and a variable-speed transmission.



Measuring Fuel Oil in Tank Cars

By H. L. Kauffman
Petroleum Consultant

ARGUMENTS between buyers and sellers of fuel oil can be avoided by the proper gaging of the tank car, with a correction for the temperature. A tank car is gaged by measuring the oil either in the dome of the tank or from the bottom of the dome to the surface of the oil.

The most commonly used method of gaging the "innage" (amount of fuel in the dome) or the "outage" of a tank car is to lean over the dome and if the car is not shell-full, measure the distance between the edge of the tank shell and the surface of the oil with a three-foot rule. Inaccurate readings, however, are likely to be obtained when using this method, in view of the fact that the man doing the gaging has difficulty in reading the mark on the rule at the point where it is even with the top of the shell. When there is fuel oil in the dome of the car, that is, innage, the common practice is to lower the rule through the oil until its end rests on the tank shell inside the dome, thereafter reading the highest point on the rule that is wet. It is not so difficult to obtain accurate innage readings.

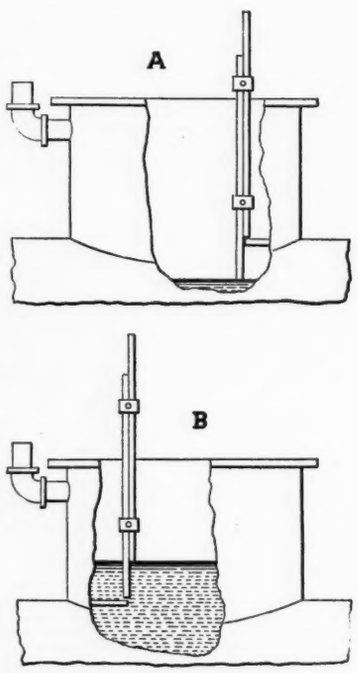


Fig. 1—Method of measuring outage and innage

A more satisfactory method is to use two rules, each 30 in. long, fastened together parallel to each other by two brass guides, which permit their traveling up and down, as shown in Fig. 1. On one of the guides is a clamp operated by a thumb screw, to control the movement of the rules. The rules are graduated in inches and in fractions of an inch, but the numbering is in opposite directions. In using this measuring device, when there is outage, Fig. 1-A, the end of one of the rules is first allowed to rest on the edge of the top of the shell. Next, the thumb-screw is tightened to a point where the other rule will not drop down, but not so tightly that slight taps on the top of it will not cause it to drop down slowly until the bottom of the free rule being tapped just touches the surface of the oil, causing a ripple. The top of the free rule is then just opposite the figure on the stationary rule that represents the distance between the top of the shell and the surface of the oil, which distance can be read from the rule without difficulty. Innage gaging with this device is identical with the procedure just described, except that one of the rules is pulled well up above the height of the oil in the top and thereafter gradually tapped down until it touches the oil surface, as in Fig. 1-B.

Standard tables are used in determining innage or outage. Table I gives the gallons per inch in tank car domes of various sizes. In using this table, merely multiply the particular number of inches of oil found to be in the dome, by the number of gallons per inch in a dome of that size. Add the result to the rated capacity stenciled on the sides of the car to get the actual contents, *uncorrected for temperature.*

TABLE I—GALLONS PER INCH IN TANK-CAR DOMES OF VARIOUS SIZES

Diameter of Dome, In.	Gallons per Inch
24	1.95
26	2.29
28	2.66
30	3.06
32	3.48
34	3.93
36	4.40
38	4.91
40	5.40
42	5.99
44	6.58
46	7.19
48	7.83
50	8.50
52	9.19
54	9.91
56	10.66
58	11.43
60	12.25
62	13.06

The temperature of a car of fuel oil should always be taken and recorded at the time of gaging, if an accurate measurement of the tank car is to be obtained, for temperature changes alter the volume of the oil. The fraction of its volume which anything expands for a rise in temperature of 1 deg. F. is called its coefficient of expansion, which numerical figure, for petroleum oils, varies somewhat with the temperature range and differs with a change in gravity, as shown in Table II.

TABLE II—FUEL OIL EXPANSION

Gravity Range, A.P.I., Baumé	Coefficient of Expansion, Per Deg. F.
79.0 and lighter	0.0008
78.9-65.0	0.0007
64.9-51.0	0.0006
50.0-35.0	0.0005
35.0 and lower	0.0004
Pitches	0.00038

If the fuel oil in the tank car is under 60 deg. F., the correction is added to the volume reading of the quantity of oil measured; if over 60 deg. F., it is subtracted.

The number of gallons of fuel oil that would be in a tank car at 60 deg. F. is ascertained by multiplying the number of gallons at the temperature gaged by the coefficient of expansion and subtracting or adding, as the case may be, the product from or to the observed gallons.

For example, if at 60 deg. F. the A.P.I. Baumé gravity of the oil is 28, 1 gal. of this oil measured at 120 deg. F. will have a volume of $1 - (120 - 60) \times 0.0004 = 0.976$ gallons.

If the A.P.I. gravity of an oil at 60 deg. F. equals 28 and the volume at 120 deg. F. equals 6,000 gal., then the volume at 60 deg. F. will be $6{,}000 \times 0.976 = 5{,}856$. This involves an insignificant error due to the fact that the coefficient is not exactly 0.0004.

Tables have been issued and approved by the American Society for Testing Materials under the heading, "Standard Abridged Volume Correction Table for Petroleum Oils," as Serial Designation D 206-25. These tables have been approved by the Bureau of Standards, the Bureau of Mines and the American Petroleum Institute. If more accurate results than obtainable by the use of Table II are desired, a copy of these correction tables can be obtained from the American Society of Testing Materials.

In conclusion, two other points of interest should be mentioned. Some fuel oils are so viscous that accurate

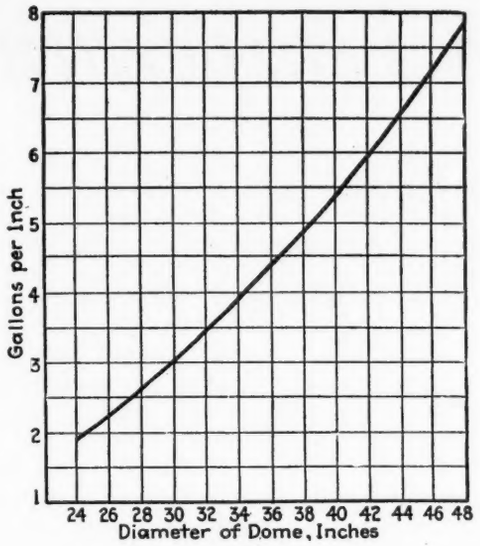


Fig. 2—Capacity of car domes

average temperature readings cannot be obtained when the oil is at atmospheric temperature. Consequently, the temperature and gage readings on such cars should be obtained only after steam has been turned into the steam coils of the car and the oil has become sufficiently fluid that the thermometer can be moved readily up and down through the oil.

The water content of a tank car of fuel oil should be subtracted from the gross volume. Water can generally be detected by barely "cracking" the outlet valve and noting the appearance of the liquid that first drips through. Thereafter, the amount of water, if present in appreciable quantities and if the car is absolutely level, can be measured either with an oil thief or by chalking a gage pole or steel tape and then measuring.

Connecting-Rod Bearing Adjustment

By G. F. McClay

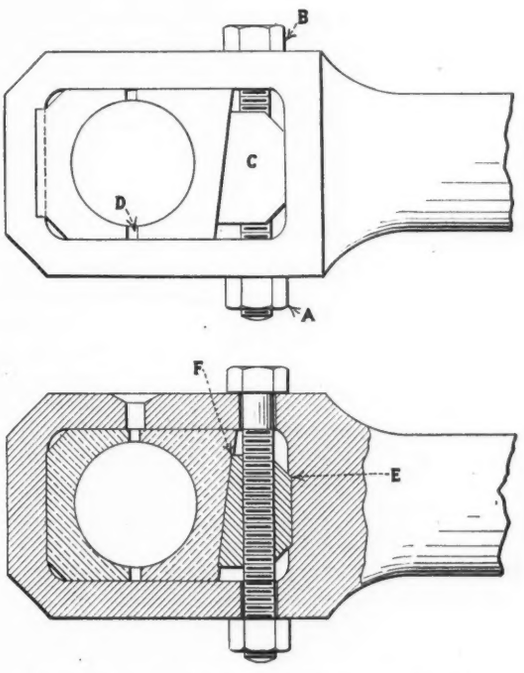
THE upper view in the accompanying illustration shows the type of connecting-rod bearings used in the majority of air compressors, this design having been handed down to us from the time when long strokes and slow rotative speeds were used. Under those conditions it was a satisfactory bearing, but with the advent of higher rotative speeds, and shorter strokes this type of bearing is not so satisfactory.

One of the main features attributed to it was that it was easy to adjust. Theoretically, this seems to be true, as all that is required is to loosen check nut *A* and turn the bolt *B* to the right, raising the wedge *C*, which closes in the taper half of the bearing. In practice, adjustment does not work out as simply as this.

Assuming that a 0.004-in. clearance on the pin for a running fit is required, a total clearance between the pin and the bearing, and between the bearing parts and the rod must be 0.004 in. This allows the parts of the bearing to move, causing them to wear away and to wear into the rod and wedge. Examination of a bearing of this type will usually reveal a condition as shown, somewhat exaggerated, in the lower view. Unless these worn surfaces on the rod and taper half of the bearing are trued up before any adjustments are attempted, satisfactory results cannot be obtained, because when the wedge is moved up it has only a small bearing surface at points *E* and *F*. These points soon wear away and leave the bearing in as slack a condition as it was before the adjustments were made. This doubtless accounts for the experience sometimes reported that a bearing has been run for a year or more before adjustment is required, and after an adjustment is made it requires adjusting as often as once a month.

Another weakness of such bearings, is that unless care is exercised in adjusting them, they may be set up too tight, which may produce more noise in the crosshead than the loose bearing did. If the crosshead-pin bearing is too tight, every time the crankpin passes over center the crosshead is alternately lifted and forced down onto the guides, producing a loud knock. An inexperienced operator might easily mistake this for a loose crosshead-pin bearing. And with an open-type box there is nothing to prevent him from tightening the bearing still more, which would probably result in a scored crosshead-pin box and crosshead guides. The same applies, although not to the same extent, to the crankpin bearings.

The bearings can be altered by introducing shims between the two halves of the bearings. If the width permits, the shims can be held in place and endwise, and up off the pin by dowels in one one-half of the box. Or the shims may be cut out in the center, to prevent their scraping the oil off the pins, and held in place by the cheeks of the crosshead. With this construction all parts



Detail of open-type connecting-rod bearing

of the bearings are drawn up tight in the rod, so that wear will not take place between the bearing parts and the rod. The bearing can be taken up a predetermined amount only, depending on the amount taken off the shims. This can be done by peeling off a definite number of layers if a laminated shim is used, or by filing a definite amount from a solid shim. A solid shim should be measured carefully to be sure the same amount is removed from both ends. This construction also allows the bearings to be fitted to the pins outside of the machine to a definite clearance and then assembled in the machine.

Steam Pressure and Temperature

Power Plant Progress Reviewed—Effect of Pressure and Temperature on Thermal Efficiency Shown

By Frank S. Clark

Stone & Webster, Inc.

This article is an abstract of a paper presented at the World Power Conference in Tokio. It presents some of the conclusions of a study made by the author and his associates in Stone & Webster to determine the effect of the various factors that should be considered in selecting the operating pressure and temperature of a central station power plant

BOTH in Europe and in the United States at the beginning of the present century, about 200 lb. per square inch was the practical maximum for the operating steam pressure, and in the United States saturated steam was used almost exclusively, the manufacture of superheaters having begun in 1898. Today, 400 lb. per square inch gage and 750 deg. represent conventional practice in America, and there is a growing acceptance of 1,200 lb. and 750 deg. for the high-capacity, high-load-factor plant. The curves of Fig. 1 show the gradual increase in steam pressures and temperatures and are derived from the annual sales of central station turbine-generators on the part of one of the larger manufacturers.

These curves, in addition to reflecting approximate average steam conditions of the central station turbine, show the increase that has been effected in average machine efficiency. The curves of Fig. 2 show the increase that has taken place in the capacity of turbine-generator units and in the efficiency of turbine-driven generators since 1904.

The first central station installation of an American-made turbine-generator was a 1,500-kw. unit for the Hartford Electric Light Company, in 1901. The efficiency of the generator was probably slightly better than 90 per cent, and the thermodynamic efficiency of the turbine referred to brake horsepower, about 60 per cent. By 1928 the single-shaft, single-cylinder turbine-generator had been developed to a capacity of 65,000 kw. for the 1,800-r.p.m. machine and to 75,000 kw. for the 1,500-r.p.m. machine; the 1,500-r.p.m. single-shaft tandem-compound turbine-generator, to 94,000 kw. A 160,000-kw. machine of this speed and type is now in operation. The improvement in steam conditions and growth in capacity have been accompanied by improvement in thermodynamic efficiency of the turbine from approximately 60 per cent to better than 80 per cent at the present time, and in generator efficiency from 90 to 95 per cent in the high-capacity machines of 1928.

Prior to about 1921, the turbine-generator had been commonly operated on the simple expansion, or Rankine, heat cycle. Reheating and regenerative cycles had long been used by a few of the more progressive builders of reciprocating engines. But the full possibilities of improving the efficiency of the heat cycle by regenerative feed water heating did not at once gain general recognition in the United States, the large-scale use of multiple extraction for regenerative feed water heating not beginning until 1923-24. Steam extraction for regenerative feed-water heating has not only enhanced the efficiency possibilities of the steam cycle, but has permitted increases in capacity of the turbine by the withdrawal of steam and moisture ahead of the relatively crowded lower stages.

Almost equally marked advance has occurred in the boiler plant. In 1900 a boiler of 6,000 sq.ft. of heating surface was approximately the maximum size in use. Hand-firing was the most common method of stoking employed, and steam-generating rates rarely exceeded 5 lb. per square foot of boiler-heating surface.

Today evaporative rates in excess of 15 lb. per hour per square foot of boiler-heating surface are not unusual. There are now either in operation or in course of construction at least thirty boilers designed for maximum continuous operation at evaporative rates of 400,000 lb. of steam per hour or higher. Five of these, to be fired with pulverized coal, are designed for 800,000 lb. of steam per hour.

At the beginning of the century boiler efficiencies better than 70 per cent were exceptional. The fuel consumption of the large central station was more commonly above than below 4 lb., or about 55,000 B.t.u. per kilowatt-hour of generated output. In 1905 representative stations both in the United States and abroad were reporting 30,000 to 50,000 B.t.u. per kilowatt-hour. In 1914 two units of one of the most efficient American stations operating on a load factor of 66 per cent generated power over a period of one month on slightly under 20,000 B.t.u. per kilowatt-hour. This, however, was by no means representative of the central stations of the period, and at the time a heat consumption of 25,000 B.t.u. per kilowatt-hour was considered highly creditable as an average of a year's performance. During the next seven years, because of the war, such improvements as were effected in design were often offset by inferior fuel, and as late as 1922 heat consumption in but

few stations fell below 20,000 B.t.u. per kilowatt-hour. The years of 1923, 1924 and 1925, with increase of steam pressure and steam temperature, the introduction of the reheating (in addition to the fuller use of the regenerative cycle), and the growing use of economizers and air preheaters brought rapidly decreasing heat consumptions. The adoption of the regenerative cycle of feed water heating not only effected marked gains in cycle and turbine efficiency, but, by giving effective impetus to the movement toward substitution of motor driven auxiliaries, resulted in the elimination of losses, rarely less than 2 per cent, due to waste of exhaust steam unused for feed-water heating.

A number of stations designed during this period and subsequently have generated power with a heat consumption of less than 15,000 B.t.u. per kilowatt-hour. The 600-lb. pulverized-coal-fired Columbia station, placed in operation at the end of 1925, attained a performance of less than 12,600 B.t.u. per kilowatt-hour on a capacity factor of approximately 65 per cent for the final three-month period of the year 1926.

Experience With 1,200-Lb. Installations

The 1,200-lb. installations in operation in the United States at this time represent only a part of the generating capacity of the respective stations, and on that account actual performance results reflecting the full benefit of operation at the higher pressure are not yet obtainable, but must await the completion of the exclusively high-pressure stations now under construction. However, from careful analyses of operating performance over extended periods, the managements of these stations have found a reduction in heat consumption of approximately 12 per cent for the 1,200-lb. equipment as compared with that of the normal pressure station of 350 lb. and a reduction of approximately 14 per cent for the 1,300-lb. equipment as compared with that of the 300-lb. normal station.

As there is but small thermal gain to be had from operation at pressures above 1,400 lb. per square inch gage, and as the natural circulation of the boiler of normal design has demonstrated its satisfactory performance at 1,400 lb., there has been little tendency shown in American practice toward adoption of special boiler construction. Definite saving in plant cost would be the only

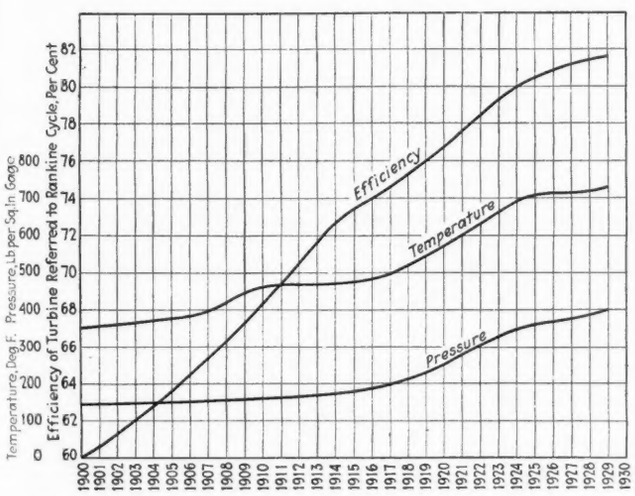

Temperature, Deg. F. Pressure, Lb. per Sq. In. Gage
Efficiency of Turbine Referred to Rankine Cycle, Per Cent
Efficiency
Temperature
Pressure

Fig. 1—Curves showing how pressure, temperature and turbine efficiency have increased since 1900

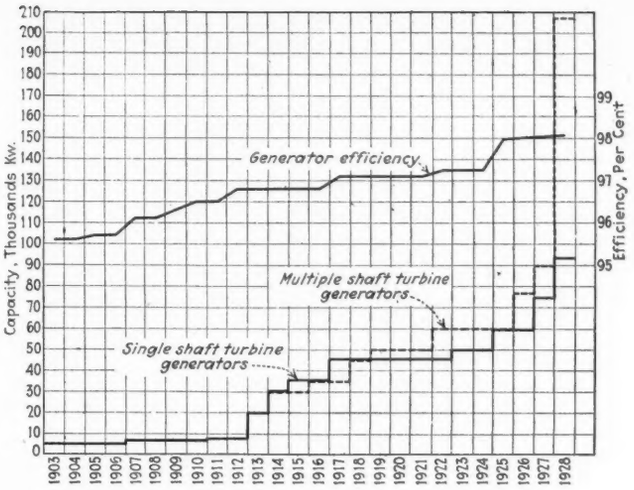


Fig. 2—Growth in capacity of turbine-generator units since 1903

conditions warranting the adoption of special boiler design.

In the studies undertaken in 1923 for selection of operating steam pressure for the Edgar station it had been determined that for the maximum steam temperatures then considered commercially available, about 700 deg., there could be but little economic gain from the use of steam pressures in excess of 400 lb. per square inch without the adoption of reheating after partial expansion, and that if reheating were employed an adequate return might be expected from the adoption of operating pressures as high as 1,200 pounds.

Fuel Economy of High Steam Pressures and Temperatures

The curves of Figs. 4 and 5, prepared from more recent data, show expectable rates of heat consumption, for the turbine-generator alone and for the complete station, under the straight regenerative and the regenerative-with-single-stage-reheating cycles, respectively, which have been estimated on the basis of certain assumptions as to turbine efficiencies, conditions of reheating, and auxiliary power requirements.

The lower series of curves of Fig. 4 would indicate that for the straight regenerative cycle with initial steam temperature of 700 deg. at the throttle the maximum thermal efficiency of the machine is attained at approximately 1,200 lb., and with initial steam temperature of 1,000 deg. is attained at very much higher pressure. On the other hand, the upper series of curves of the same figure show that for initial temperature of 700 deg. at the throttle the rate of reduction in heat consumption, or gain in efficiency, decreases rapidly above 400 lb. pressure, and that the point of maximum thermal efficiency for the station as a whole is below 1,000 lb. per square inch gage pressure. Furthermore, practically no gain in net thermal efficiency is to be had on this cycle with either three-stage or four-stage regenerative feed water heating by increasing initial throttle pressures beyond 1,400 lb. per square inch gage, even for initial steam temperatures as high as 1,000 degrees.

Fig. 5, giving the corresponding data for the regenerative reheating cycle, shows, in the lower series of curves, progressive improvement in thermal efficiency of the turbine-generator to the limit of pressure range covered by the chart; but because of the increase in auxiliary power consumption accompanying the increase of

pressure the net thermal efficiency of the station with single-stage reheating is shown, in the upper series of curves, to reach a maximum, for initial and reheating temperatures of 700 deg., at approximately 1,400 lb. per square inch gage pressure. Increasing the reheat temperature to 900 deg., with an initial temperature of 800 deg., will raise the pressure for maximum thermal efficiency somewhat higher, but the gain due to pressure increase beyond 1,400 lb. per square inch gage is small. On the other hand, at any pressure, increase of either initial or reheat temperature effects marked improvement in the thermal efficiency of the station.

In comparing the two charts it will be noted that the efficiency of the regenerative-with-single-stage-reheating cycle for 700 deg. initial and reheating temperatures at a pressure of 1,200 lb. per square inch would be approximately equaled by the straight regenerative cycle at the same pressure with an initial temperature of about 824 deg. and four-point extraction, or at slightly below 700-lb. pressure with initial temperature of 900 deg. and four-point extraction.

Although the curves of Fig. 4 would indicate possibilities of thermal gain by use of steam pressures as high as 900 lb., under the straight regenerative cycle for either three- or four-point extraction with initial temperatures of 700 deg., or by use of pressures as high as 1,400 lb. with four-point extraction and initial steam temperatures of 800 deg.—the curves of Fig. 6 show that for initial steam temperature of 700 deg. moisture at exhaust becomes excessive at pressures materially above 500 lb., that

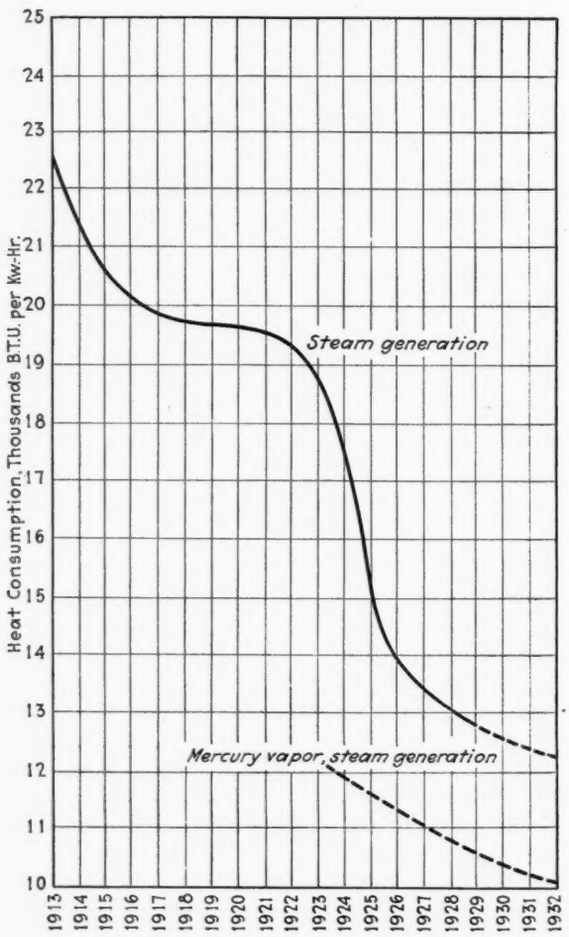


Fig. 3—Decrease in station heat-consumption rate, except for the war period, has been continuous

for initial temperature of 800 deg. equivalent moisture conditions are encountered at about 800 lb. per square inch gage, and that for 900 deg. initial temperature equivalent moisture conditions are encountered only at 1,200 lb. per square inch gage.

Developments in Higher Steam Temperatures

The most promising field of improvement for the steam cycle would seem to be in the direction of increased steam temperatures. Since 1925 boiler and turbine equipment has been in operation with steam conditions of 800-lb. pressure and 842-deg. temperature at the Langerbrugge station of the Central Electric Company of Flan-

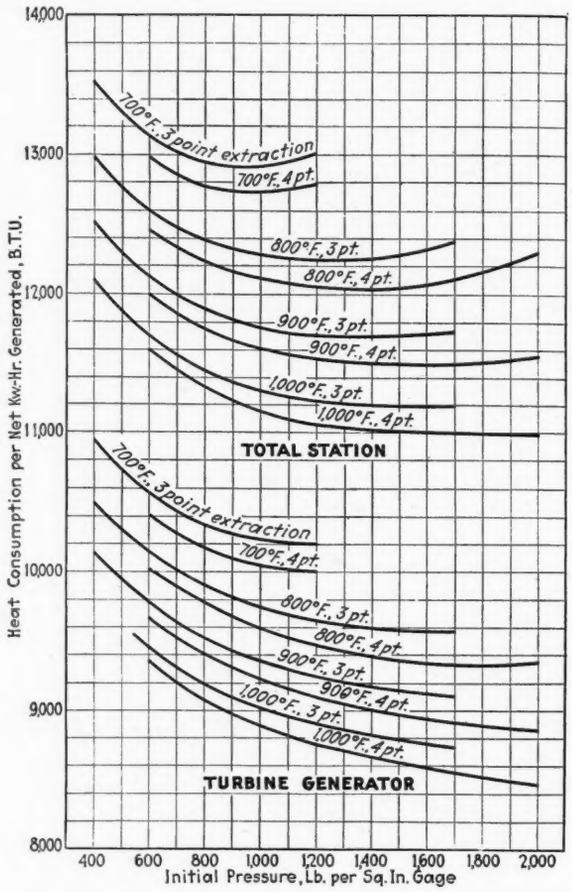


Fig. 4—Variation of heat consumption rate with initial pressure and temperature for a plant operating on the regenerative cycle

ders. That station includes the only complete power-generating installation that has been operating for any extended period at temperatures materially above those used in present American practice. However, the Detroit Edison Company is placing in operation an experimental superheater and turbine of 10,000 kw. capacity designed to operate under steam conditions of 380-lb. pressure and 1,000 deg. temperature. The superheater is designed for a maximum temperature of 1,100 degrees.

While further gains in thermal efficiency may be made, it would seem of greater immediate importance to effect a reduction in plant cost. This can be had by simplification in design, standardization of operating pressures and equipment capacities, and more efficient use of building space. In the boiler room marked savings are to be had through more economic distribution of heat-absorbing surfaces, the minimization of boiler-heating surface, the more general use of steaming-economizer surface

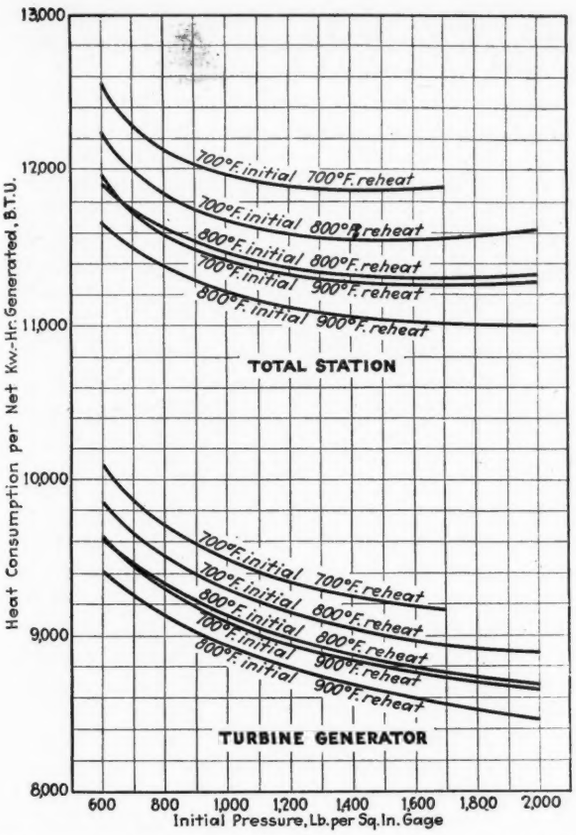


Fig. 5—Variation of heat-consumption rate with initial pressure and temperature for a plant operating on the reheating regenerative cycle

and, whenever economically warranted, greater area of air preheater surface. While the increased rates of evaporation have resulted in increased output per unit of horizontal section, this apparent gain has been offset by the increases made in furnace volume.

An important problem of power production that seriously enters into the design of the public utility station is providing for the peak loads of relatively short duration. In Europe, notably in connection with the system of power supply for Berlin, the steam accumulator in conjunction with the variable-pressure turbine-generator is being tried on peak service. In the United States the most conspicuous measures taken for the purpose of reducing the cost of meeting peak-load requirements have been the use of equipment of large overload capacity designed to give the maximum thermal efficiency at materially less than maximum rated load. Thus the continuous loading will approximate the point of maximum fuel economy, while capacity is provided to handle the maximum load at some sacrifice in fuel.

For any station intended for public utility service, reliability is the essential requirement. For stations of low load factor, below 25 per cent, the next controlling factors in the design will be, in general, capacity, simplicity and ease of operation, and quick starting ability, with thermal efficiency not of special importance except in so far as it may affect plant capacity. Except under conditions where the demands on the plant are anticipated to be of comparatively brief duration, it is frequently found advantageous in stations of this type to water-cool the furnace walls, merely to increase effective capacity.

For stations intended to operate on somewhat higher load factor, 25 to 55 per cent, such as obtain on the average electric power system in the United States, fuel economy becomes of greater importance, and, depending upon the anticipated load factor and fuel cost, additional equipment or additional capacity in equipment may be included for reasons of thermal efficiency alone. Stations to serve this class of load, unless of very large capacity, will generally be designed for a steam pressure of 400 to 450 lb. and steam temperature of 700 to 750 deg., and will include either air heaters or economizers, or possibly both types of heat-conserving equipment, if justified by fuel costs and anticipated load factor.

A number of high-capacity stations for high load factor operation are now under construction for pressures of 650 lb. and 1,400 lb., with steam temperatures of 725 to 750 deg. Cost comparisons prepared early in 1928 on the basis of experience in design and construction of the 1,200 and 1,400 lb. installations at the Edgar and Lakeside stations, and on the basis of design of the Holland and Deepwater stations, indicated that for units of 50,000 to 60,000 kw. capacity the 1,400 lb. and 750 deg. steam stations would cost, as a maximum, 5 per cent or 6 per cent more than the station designed for 400 lb. with the same initial steam temperature. This differential will unquestionably increase with a decrease in the size of the unit, and, on the other hand, will decrease with an increase in unit capacity. Some reduction in costs of the higher pressure equipment is also to be expected with acquired experience, increased volume of production, and stabilization of manufacture.

Where limitations of available water supply are of importance in meeting requirements for condensing pur-

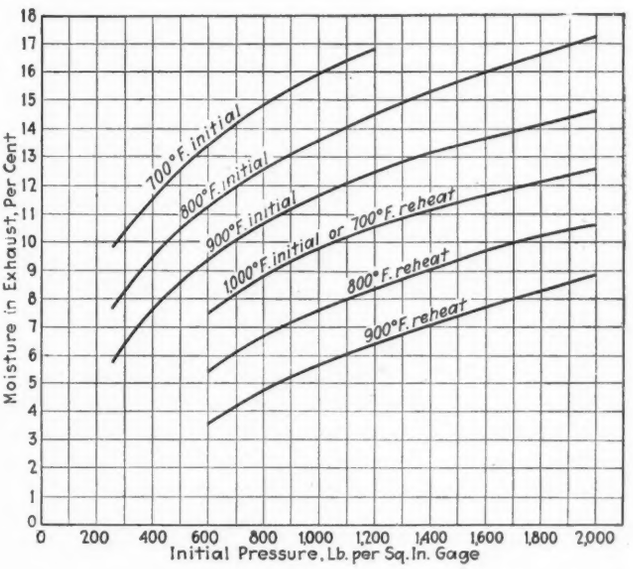


Fig. 6—Moisture in turbine exhaust for various initial steam conditions

poses, it will frequently be of advantage to adopt high steam pressures and temperatures for units of smaller capacity, because of the reduction obtained in quantity of heat to be absorbed in the condenser. Where industrial processes of sufficient magnitude and permanence require steam of 400 lb. per square inch gage, or even lower pressure, it may be advantageous to adopt 1,200 or 1,400-lb. pressure for the station, thus permitting the steam to first be used for power generation, as in a part of the Deepwater station. In general, however, the field of the high-pressure high-temperature plant, at least for the immediate future, would seem to be the high-capacity, high-load-factor central station.

Modern Feed-Water Treatments Are of Four Kinds

IN ORDER NOT TO BECOME LOST *in the mass of details that is available concerning every conceivable topic, it is necessary at times to formulate brief statements of essential facts. In this article Mr. Hayward presents a simple statement concerning modern practice in the treatment of boiler feed water that is distinctly useful in aiding the reader to think clearly on this subject.*

BY L. W. HAYWARD
Combustion Engineering Corporation
Kansas City, Mo.

IN THE last few years, due to high boiler ratings and high steam pressure, the importance of good feed water has been impressed more strongly upon us. We hear about water with zero hardness, about internal and external treatments, about caustic embrittlement of metal and about various chemicals and chemical reactions which should take place before and after the water enters the boiler.

If distilled water could be used in boilers, we would hear little about feed-water treatment, for there are no impurities in distilled water. Boiler feed water not obtained from the condensing of steam, or, that is, not distilled, is usually pumped from wells, rivers or lakes. This water is not pure, but contains foreign matter of different kinds, called solids or salts. Some of these solids can easily be seen by allowing the water to settle for a short period of time after it has been heated or treated with certain chemicals, as the solid matter then drops to the bottom of the container. As water continually fed to the boiler is converted into steam, the impurities remain in the boiler, as they do not pass off with the steam. These impurities, therefore, gradually accumulate either in solution or in suspension in the boiler water or settle out as mud and scale.

The amount of foreign matter in solution and in suspension in the boiler water is known as concentration. The concentration is the percentage of solid matter in a definite portion of water, as so many parts of solid matter per million parts of water, or so many grains of solid matter in each gallon of water (a gallon of water equals approximately 58,480 grains). The allowable concentration under average operating conditions in the boiler will vary from 50 to 1,000 grains per gallon, depending to a large extent upon the ratio of solid matter in suspension to that in solution and upon the rate at which the boiler is operated.

To keep the concentration within limits and to remove the mud which accumulates, the boiler is blown down at intervals. This reduces the amount of water in the boiler, and the incoming feed water dilutes the remaining water, thus reducing the concentration. When the feed water contains a high percentage of solid matter, the frequency and amount of blow-down required is excessive and greatly reduces the efficiency of operation due to the heat carried off with the blow-down water.

The old method of adding certain chemicals through a small proportioning device or pump as the water was fed to the boiler helped to convert some of the scale-forming solids to non-scale-forming solids, keeping these solids in solution or in suspension until they could be removed from the boiler through the blow-down. This method is simple, requiring very little external apparatus, as the chemical reactions take place in the boiler. It is used to a large extent today in small plants.

Most methods of conditioning water now in use not only attempt to reduce the scale-forming solids but also attempt to reduce the loss due to excessive blow-down. Several distinct forms of treating water are in use:

1. To treat the feed water with chemicals before it enters the boiler, so as to change some of the foreign matter from scale-forming solids to solids that can be filtered out before the water enters the boiler and to change the remaining solids to non-scale-forming solids in solution which pass to the boiler with the feed water. Heating the feed water helps the chemical reactions in this method of treatment. Mixing tanks, settling tanks or filters are required. With this method no scale-forming solids or suspended solids should be found in the boiler if the treatment is 100 per cent effective, but as non-scale-forming solids in solution are fed to the boiler, the concentration will build up.

2. The zeolite method of treating water converts all the scale-forming solids to non-scale-forming solids that remain in solution in the water. This treatment takes place before the water enters the boiler. With this method zero hardness is obtained and no scale is found in the boiler. However, if the raw water contains a good deal of foreign matter the non-scaling solids in solution in the boiler will build up very rapidly and require an excessive amount of blow-down and thus greatly reduce the boiler efficiency. For this reason continuous blow-down apparatus, with heat exchangers, is usually installed or recommended with this form of treatment. With a continuous blow-down, a definite amount of water is removed from the boiler continuously. The heat exchanger recovers a portion of the heat from the water which is blown off, and the recovered heat is usually used in heating the feed water.

3. Another method is to add certain chemicals to the feed water as it enters the boiler, which change the scale-forming solids to solids in suspension and in solution. The solids in suspension are removed by re-circulating a definite portion of the water through settling tanks or filtration tanks and returning it to the boiler with the suspended solids removed. The amount of blow-down required with this method is less than with the zeolite method, as the amount of solids in solution is much less. However, a certain amount of blow-down is required to reduce the concentration due to the soluble solids, as these cannot be removed by filtration or precipitation.

4. The combination of the first and second methods of treatment as described above is sometimes used, also the combination of the second and third methods.

Any of the above methods of treatment coupled with careful attention to the prevention of undue concentration will result in the elimination of scale in the boiler and foaming and priming over the entire range of boiler rating. However, the amount of foreign matter in suspension and in solution varies in composition with the different methods, and in each case danger due to pitting, corrosion or plate embrittlement has to be watched. It has been shown that plate embrittlement often occurs in boilers containing a high percentage of soda. It is necessary to watch the solids in solution and maintain a definite ratio between alkalinity and sulphate salts to eliminate the danger of embrittlement.

Right Out of the Plant

Eliminating Header Vibration

To eliminate any serious vibration in a steam header leading to an engine, I suggest the simple and inexpensive expedient of inserting a sheet-steel diaphragm with an opening one-half that of the pipe, at a flange joint near the header; or, in case a receiver is already installed, place the diaphragm at the receiver.

Take a steam-pressure diagram before and after, and if the throttling effect is noticeable, enlarge the opening in the diaphragm. In several instances this method has eliminated vibration, and the surprising thing about it is the fact that it caused little difference in the steam pressure at the steam chest.

A receiver should always be used near the throttle of any engine, but it might be necessary to put in a section of larger pipe to act as such if a regular separator or receiver is not available. LANCELOT COPLESTON.

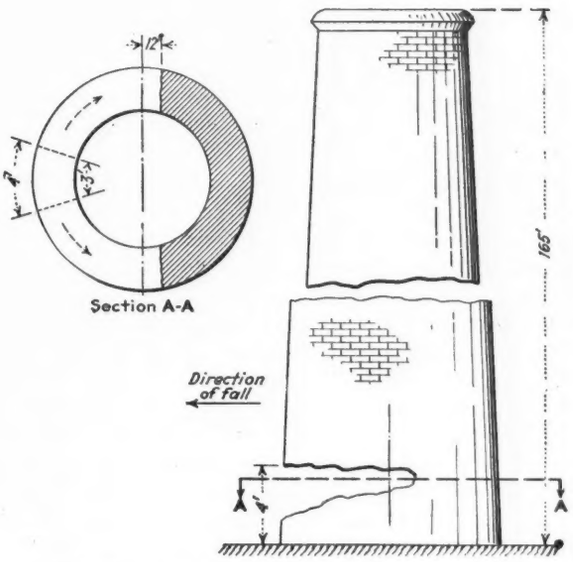
Coxsackie, N. Y.

How a Brick Chimney Was Razed

IN THE municipal electric light plant at Hamilton, Ohio, a radial brick chimney 165 ft. high and about 13 and 9 ft. in outside diameter at bottom and top, respectively, was torn down recently by undermining it. The job was done by two men, each with an air chisel, in about 10 hr.

As shown in the sketch, a hole of about 4 ft. wide at the outer wall and 3 ft. wide at the inner wall was first made about 4 ft. above the ground at the side in which the chimney was expected to fall. Then chipping was done toward both sides, one man working at each side and proceeding at the same rate. When it was undermined one foot beyond its center line, the chimney fell, breaking at two points at the heights of about 30 and 40 ft. from the ground shortly after it began to fall. This can be seen in the photograph. The bricks were spread for a distance of 125 ft. from the base. T. H. CHEN.

Hamilton, Ohio.



Details of undermining at base of chimney

View of chimney taken as it fell

Reducing Power of Low-Pressure Cylinder

I AM always interested in reading *Power,* and in the Nov. 12 issue the first question and answer in the "From Among Readers' Problems" pages claimed my attention.

The question read: "How can you increase the load that is being carried by the low-pressure cylinder of a cross-compound engine?"

I would like to add something to the answer following the question. In compound steam engines changing the point of cut-off in the high-pressure cylinder effects a change in the power developed in the engine as a whole. But to change the relationship between the powers in the individual cylinders, it seems that a change in point of cut-off should be made in the low-pressure cylinder rather than in the high-pressure. With a given engine developing a certain power, if it is desired to have the low-pressure cylinder carry more load than at present, then the cut-off in that cylinder should be decreased, which, in turn, builds up the receiver pressure, increases the mean effective pressure, and at the same time increases the back pressure in the high-power cylinder and so reduces the power in that cylinder. The total power remains the same as at first.

In the answer given to the question, increasing the

high-pressure cut-off, that is lengthening it, means that the engine as a whole will be capable of carrying more load, which may not be needed. It may be possible that with the low-pressure cut-off unchanged, the low pressure will carry more load than before; but so also will the high-pressure cylinder carry more load than before. However, it seems doubtful as to whether the low-pressure cylinder will carry more load in proportion to the high-pressure than it did at first.

Brooklyn, N. Y. CHARLES J. MASON.

Making Warped Turbine Casing Joints Tight

THE blowing and hissing of steam from turbines is anything but a pleasant noise in an engine room. Modern turbines only in rare instances need gaskets between the upper and lower halves of the casing. In the older types of turbines a gasket has to be used, especially when there are flaws in the casting or irregular conditions of the planed surfaces. Considerable difficulty is experienced in some plants in keeping the upper and lower halves of a multi-stage turbine tight, especially where the halves join at the ring casing on the high-pressure end. We were confronted with the same problem some time ago, and it occurred to me that the method we used to overcome it might be of interest.

First we tried using a lead, copper and asbestos gasket, with poor results. The packing must be just the right thickness. Too thick a packing on the nozzle ring and ring casing will tend to keep the top and lower halves of the casing from butting; likewise, too thick a gasket between the upper and lower halves will give a space between the nozzle ring and upper half of the casing, with the result that steam will blow over the nozzle ring and greatly impair the efficiency of the turbine.

It is needless to try to make a turbine of this type tight at the horizontal body joint if the necessary precautions were not used throughout the entire assembly. Before lowering the turbine spindle into position, the lower casing should be smooth and freed from all burrs and dirt.

It is imperative that every little detail is taken care of before lowering the spindle into the turbine. The studs in the stationary diaphragms should be down in their respective grooves. Give the lower half of the casing a coating of graphite mixed with cylinder oil. Should the nozzle holes be out of line they can readily be brought to their proper position by inserting a bar into the nozzle ring and forcing the ring to its place. The same precaution should be used when lowering the top half of the casing. By using a small lead wire for a gasket (about 10-amp. fuse wire) and taking up on the nuts gradually and evenly all around, a tight joint should be secured. Of course, if the turbine casing is warped considerably it will be difficult to make a permanently tight job, but by following the instructions outlined here one should be able to make a tight job.

Assuming you have the top half of the casing off, make sure that the upper and lower halves are clean and free from dirt, and go over the planed surfaces with a fine file. Set the top half of the casing on and pull it down with a few bolts to make sure it is down all around. (Generally the warpage is found around the high-pressure side.) Take your feeler gage and insert the thickest leaf that you can, and slide it around as far as you can; now make a mark on the lower casing to coincide where the feeler gage entered and stopped. Also mark the thickness of the leaf.

Proceed in a like manner around the casing where it is warped. It is a good idea to try the feelers all around the casing, as in this way one can determine with a fair degree of accuracy the true condition, and it facilitates making a skillful job later. If you find the openings are quite large, you may have to use annealed sheet copper graduated to the varying thickness, as indicated by the feeler gage. However, this is necessary in extreme cases only.

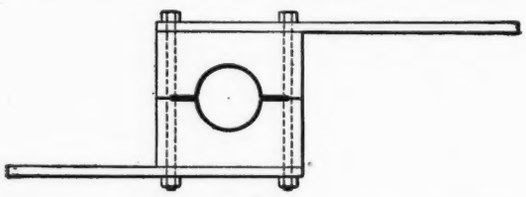
When you take the top casing off again you can cut copper of the different thickness and slip it over the studs where you have your marks. Now take a vulcanizing type of packing and cut it in strips of about $\frac{3}{8}$ or $\frac{1}{2}$ in. wide, lay it inside and outside of the bolt circle, piecing it wherever you wish, as the packing vulcanizes when steam is applied to the machine.

New Haven, Conn. PHILIP T. HYNES.

A Device for Trueing Engine Crankpins

THE accompanying sketch shows a hand-operated device for trueing an engine crankpin. It consists of two wood blocks with a hole the same size as the crankpin. The blocks are held together by two bolts and are fitted with two handles.

When desired to smooth a crankpin, the pin itself should be covered with oil, a piece of fine emery paper should be placed in the blocks and the fixture clamped on



Hand-operated tool for surfacing crankpins

the pin. Just sufficient pressure should be put on the bolts to make the paper bite the steel. The device should then be turned round to grind the pin.

If possible, the crankshaft should be removed from the engine to enable the device to be used freely; but if this cannot be done, by shortening the handles the device can be used with the crankshaft in position. In a short time this device will remove any slight ridges on the crankpin.

Brentford, England W. E. WARNER

Pulverizing Wet Coal

I READ with interest the article in the Oct. 1 number of *Power* by G. H. Suhs describing the plant recently installed at the Rhinelander Paper Company. His statement on page 516, dealing with the matter of pulverized-fuel-burning equipment as contrasted with stokers seems to carry the impression that an exhaustive investigation was made before a decision was reached, and that the decision to employ stokers was predicated upon the feeling that the high-moisture coal available to the section could not be handled successfully in pulverizers.

It is well known that certain types of mills, because of their close clearances, their method of feeding, and the

small amount of combustion air handled through the machines, are badly hampered in handling coal having any considerable degree of moisture content. On the other hand, it has been proved that mills built with positive feed, wide clearances and handling practically all the combustion air through the machine have operated satisfactorily at 10 per cent above rated capacity, with a moisture content as high as 18 per cent and ash of 14 per cent.

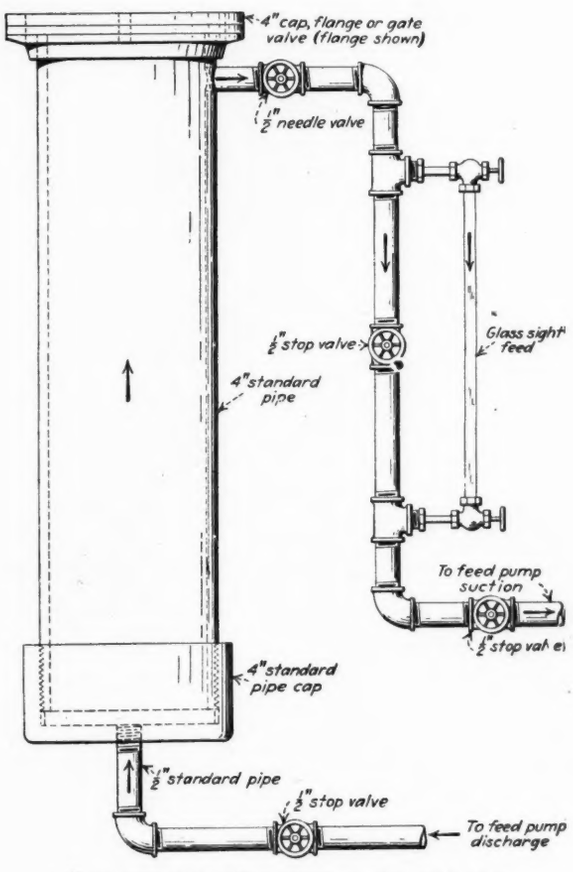
This particular case is cited from the statement of the Twin City Rapid Transit Company, of Minneapolis, Minn., in the Prime Movers Report on Pulverized Fuel for 1927. In the summary this statement concludes that Central Illinois coal of 9,800 B.t.u. per pound of coal, containing 14 per cent ash and 18 per cent moisture can be burned very satisfactorily using preheated air and taking all the air through the mill. Many similar cases can be cited.

BERRY ERVIN.

Minneapolis, Minn.

Complete System for Feeding Boiler Compound

IN THE Nov. 19 number of *Power* there was an article entitled "Complete System for Feeding Boiler Compound." The article and the sketch show very clearly an adequate and efficient method of applying a certain definite number of pounds of boiler compound in bulk to an individual boiler according to the conditions found by analysis of the water in each boiler. The whole theory, however, strikes me as being based entirely on wrong premises.



Compound feeding device adaptable for chemicals in solid form

From the article it appears, if I do not misunderstand the author, that the boilers are left for 24 hr. without any treatment and at the end of this period chemicals are fed to the boilers in amounts determined by analysis of the water.

One out of two possibilities may be assumed. Either the chemicals fed to the boilers are adjusted so that they will just neutralize the impurities found in solution in the water at the time the test is made (in which case there is no excess of chemicals to take care of the precipitate that will be thrown out of the water during the next 24 hr.), or the theory may be that an extra dose should be fed to the boilers, based upon previous test observations and sufficient to take care of similar concentrations that will build up during the next 24 hr., granting that history repeats itself.

In the former case it is unavoidable that the impurities, in any case the sulphates, will bake on the tubes or sheets during the next 24 hr. In the latter case, the boiler is overcharged with chemicals at the beginning of the period; and particularly if soda ash is used as a converting medium and if the boiler is overloaded, there has been created a condition most conducive to priming and foaming.

Anv boiler chemicals or compounds should be fed to the boiler evenly and continuously in direct ratio to the evaporation. Under no conditions should the balance between these two factors be radically disturbed if best results are to be obtained.

A method which I have used to advantage is shown in the accompanying illustration. It is admitted that this procedure does not give minute accuracy, but in the first place it is cheap and in the second place, except where high pressures and overloads are considered, it feeds the chemicals to the boilers accurately enough for general purposes.

In a battery of boilers the densities will sometimes build up, it is granted, in an uneven and unbalanced manner which is difficult to explain. One boiler will absorb more chemicals than another, the evaporations of the individual boilers will be different, but for practical purposes, and if the application of chemicals is based upon the boiler requiring most, the slight excess that will enter the boiler requiring least chemicals will not cause any harm or complications.

The device shown in the illustration is particularly adaptable for chemicals in solid form. For liquids and powdered chemicals an ordinary drip tank arranged similar to the tank shown in the article referred to, with a gage glass and a drip cock will do the trick. The dissolved chemicals can be fed to the hot well, to the heater or any other place in the system that lends itself to the purpose. In an entirely closed system, where a high degree of accuracy is required, the more elaborate method shown in the article can very well be used. In that case the chemicals should be pumped into the boilers continually and evenly in accordance with the evaporation evident from the flow meter or otherwise determined, and not intermittently, as seems to have been done in this case.

Where an automatic make-up feed regulator is used, the drip valve from the chemical tank should be actuated by the regulator and float in the constant-level feed tank applied under such conditions.

The proper feeding of boiler compound is an important subject that has not received the attention it deserves.

J. H. GULLAK.

New York City.

What's New in Plant Equipment

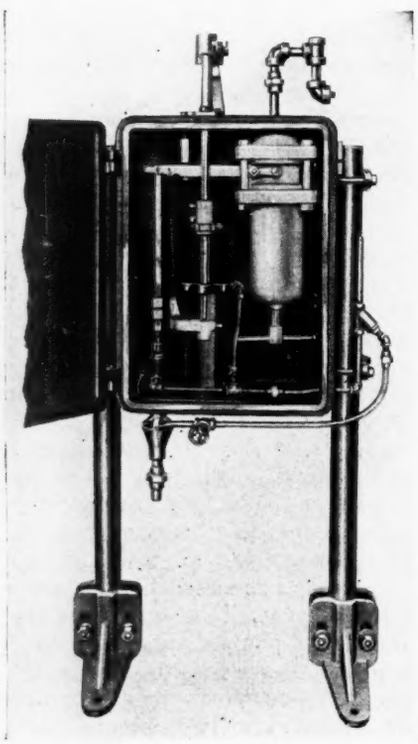
HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Combustion Control Designed for Close Regulation

DESIGNED especially to provide sensitive, close and accurate control on low loads, the Lee precision control now being put out by the Gillette-Vibber Company, New London, Conn., has three variable characteristics—pressure range, stroke range and time range.

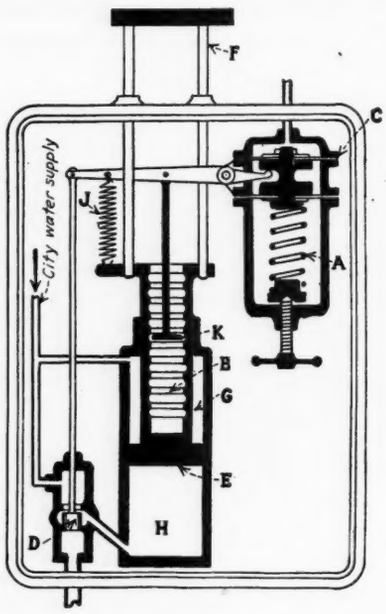
Referring to the schematic diagram—the pressure range is determined by the size and adjustment of the spring *A*, the time range by the clearance on the oil dash pot *B* and the stroke range by a link-lever mechanism at the back of the control box.

The operation of the regulator is as follows: The boiler pressure, is



Lee precision draft control

connected above the diagram *C* and is balanced by the spring *A*. This diaphram unit moves with the slightest change in pressure, as there is no internal friction, and this in turn



Schematic diagram showing arrangement of operating parts

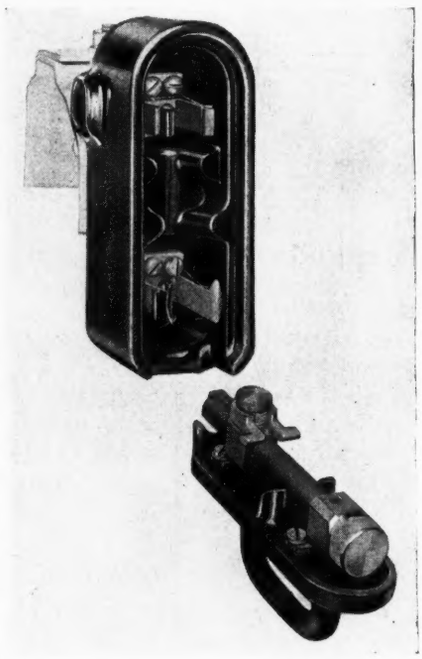
moves the pilot valve *D*, which movement causes an increase or decrease in the pressure below the piston *E*. This change in pressure causes a corresponding change in the arms *F* and likewise the lever connected directly with the valve or damper. Constant service water pressure is maintained in the cylinder *G* and above the piston *E*, but as the area above the piston is only one-half that subjected to the pressure in the cylinder *H*, any slight change in pressure causes the piston to move. The amount of this movement is determined by the range spring *J* and the time it takes to move the piston is determined by the step-control dashpot *B*. The bore of the dashpot is fitted with a series of grooves to give a dampening effect to the movement of the piston *K* and thus eliminate hunting of the control.

The mechanism on the back of the box, which houses the control, consists of a system of levers linked together in various positions and so arranged that their positions can be changed to properly fit the stroke of the control to the stroke of the valve or damper. The range that can be covered by this lever mechanism is from 2 to 30 in., and a toggle effect is incorporated whereby the first quarter opening of the valve or damper is very slow compared with the last quarter. This feature tends to smooth out the operation of the unit to which the control is connected and to obviate hunting.

Sensitivity is one of the principal advantages claimed for the control, a variation in pressure of less than one-tenth of a pound giving a sufficient impulse to operate it. By reason of the small impulse required, the control responds readily to any load change, but the compensating device checks it temporarily unless the pressure change continues.

Box Fuse for Small-Capacity Circuits

A NEW small 2,300-volt, 30-amp. fuse designed to meet the demand for economical protection of



Box fuse with cartridge removed

small circuits has been brought out by the Line Material Company, South Milwaukee, Wis. The housing is of high-grade wet-process porcelain with a flashover valve between terminals and hanger of 28,000 volts

dry and 14,000 volts wet. The contact clips are double phosphor bronze to insure evenly distributed pressure on the contact blocks.

The cartridge lower terminal is provided with lugs which fit over projections on the lower contact clips and which serve as a hinge for the door. After the cartridge has been inserted in the lower contact clips and swung back so that the lower portion of the door rests against the lower part of the box, the fuse is closed by striking the handle with the palm of the hand. This arrangement insures quick positive closing of the circuit.

The fuse has an over-all width of 3 in. and a height of 6 in.

Rock Wool Blanket

MADE in three thicknesses—1 in., 1½ and 2 in.—and in standard widths of 24 and 36 in., the rock wool blanket now being offered by the Union Fibre Sales Company, Winona, Minn., is made in a continuous bat, and can be rolled out much the same as cotton batting and

Blanket is put up in rolls 18 in. in diameter

cut with an ordinary large straight-blade knife.

The rock wool is made from pure limestone rock and is said to be free from chemicals and other impurities. It is fireproof and will withstand temperatures of 2,000 deg. without change in form.

In the blanket the fibers lie in horizontal planes. Owing to the fact that long fibers are used, the strength and insulating efficiency of the blanket are said to be much greater than when shorter and finer fibers are used.

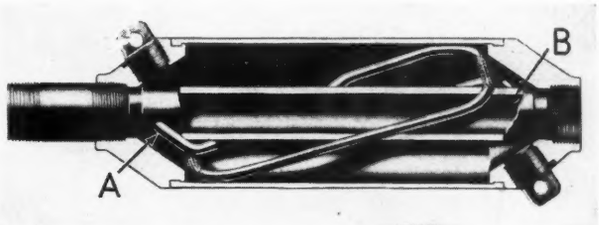
The new blanket is particularly suitable for the making of fabricated blankets in which the rock wool is put between wire netting or metal lath.

In addition to the two widths already mentioned, it is expected that blankets in any width from 1 to 6 ft. will shortly be available.

Air-Line Lubricator for Pneumatic Tools

TO MEET the demands for a simple and practical device for lubricating the lighter weight pneumatic tools, the air-line lubricator shown in the illustration has been brought out by the Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

The lubricator consists essentially of a cylindrical reservoir with a centrally located tube, around which there is a still smaller tube with a strainer screen in each of its two loops, as shown. The two ends of the small tube enter the center tube at opposite ends and on opposite sides, as at *A* and *B*, and the operation of the lubricators is effected through the differential pressure between these two points.



Longitudinal cross-section of type D air-line lubricator

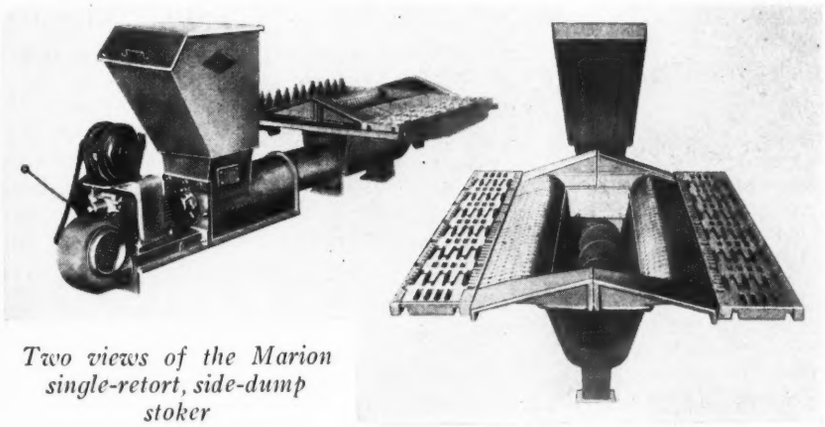
The oil in the reservoir is under pressure as soon as the air is applied to the lubricator, and the oil is carried into the line by the flow of air through the small tube. The oil enters the small tube through the screened openings, and by using two of these openings, one at each end, and on either side of the main air tube, a steady supply of oil is assured, regardless of the position in which the lubricator is placed. The function of the lubricator is assisted by the air pulsations due to the intermittent action of the tools on which the air is used. These pulsations tend to increase the turbulence within the center tube, and stimulate the admixture of the confined air and oil, helping to bring about more complete atomization. The lubricator is put out in pint and quart sizes, 8 and 12 in. long, respectively.

Single Retort Side-Dump Underfeed Stoker

DESIGNED especially to burn the cheaper grades of coal, such as screenings, slack, lignite and buckwheat, the single-retort underfeed stoker now being put out by the Marion Machine Foundry and Supply Company, Marion, Ind., is built in sizes suitable for boilers up to 2,000 sq.ft. of heating surface. Two views of the stoker are shown in the accompanying illustration.

Coal is fed from a covered hopper by a screw to a central retort, where it is forced upward and outward as it is burned to side dump grates placed parallel with the retort. These side dump grates are designed to give a crushing action to the clinkers as they are dumped to the ash pit. The conveyor screw spiral is made of steel and is welded to a heavy steel shaft. The thrust of the screw is taken by an anti-friction roller bearing. The screw shaft is also fitted with a safety collar to prevent damage from foreign material entering with the coal.

The tuyeres between the retort and the dump grate through which the air is admitted for combustion are



Two views of the Marion single-retort, side-dump stoker

made in narrow section to permit easy replacement. The combustion air is supplied by a small ball-bearing multi-blade fan placed directly in front of the gear box or transmission.

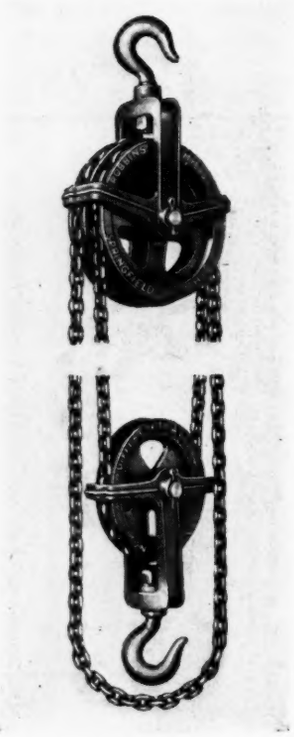
The complete unit is driven by a ball-bearing motor mounted on the top of the transmission and connected to both the fan and transmission through V-belts.

The transmission is a three-speed unit of the automotive type completely equipped with anti-friction bearings. The entire drive and fan are completely housed (not shown) to protect them as much as possible from dirt.

Each stoker is furnished with an automatic pressure or temperature control that automatically starts and stops the motor with the fluctuations in load.

Differential Chain Hoist

FEATURES of the differential chain hoist announced by Robbins & Myers, Inc., Springfield, Ohio, are anti-friction thrust bearings on the



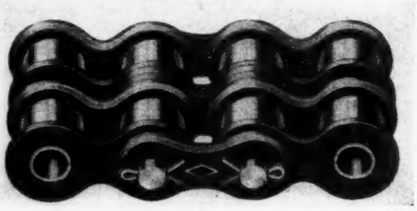
Chain hoist which is . . . . . available in ¼- to 2-ton sizes

lower hook to permit easy turning of the load; sheaves of an alloyed iron of high strength and unusual hardness; and aluminum finish throughout except on the chain. The chain is a special analysis steel, heat-treated and electrically welded. The hooks are forged steel, heat-treated, and swivel freely; while the frames are of heavy malleable iron of high tensile strength.

The hoist is manufactured in five sizes, in capacities from ¼ to 2 tons, inclusive. The regular lifts range from 6 ft. for the ¼-ton size to 9 ft. for the 2-ton size.

New 2½-In. Pitch Roller Chain for Heavy Duty

TO MEET the demand for a heavier, larger pitch roller chain the 2½-in. pitch chain shown in the



Section of roller chain

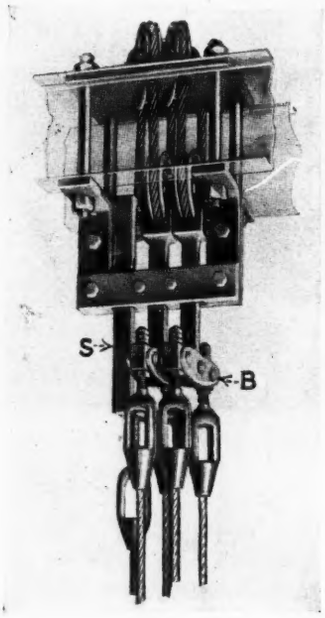
accompanying illustration has been developed by the Diamond Chain & Manufacturing Company, Indianapolis, Ind. This chain conforms to the A.S.M.E., S.A.E.,, A.S.M.A., and the American standards. It is similar in design to the line of Diamond roller chain made by this company, but is made especially for heavy-duty applications, such as on large conveyors, industrial locomotives, and similar equipment.

For single-strand chain, the average tensile strength is 95,000 lb.; maximum horsepower, 97 with 19 tooth sprocket; and maximum r.p.m. 240. It is made in single and multiple strands, transmission capacity and tensile strength being proportional to the number of strands.

Equalizer for Elevator-Compensating Ropes

IT IS generally recognized that there can be unequal loading of the hoisting ropes on traction elevation machines, due to unequal tread diameter of the traction-sheave grooves. To overcome this difficulty it is quite common practice to install an equalizer on the car end of these ropes. The possibility of unequal loading of the compensating ropes and slip in the sheave grooves is not so generally appreciated.

Recently the Evans Elevator Equalizer Company, Chanin Building, New York City, placed on the market an equalizer designed especially for compensating ropes on traction elevators. This equalizer is a modified form of the company's well-known Evans equalizer for hoisting ropes. As shown in the figure, the compensating-rope equalizer is designed to be attached to the safety plank under the car. Where there are five ropes, as in the figure, four of them are grouped in pairs attached to the ends of the equalizing bars *B*. The bars are attached to sheaves. An equalizing rope runs through these sheaves, and sheaves in the stationary part of the equipment. One end of this equalizing rope is made fast in the stationary element, and the other end is attached to the fifth rope through safety bar *C*. It is evident that this arrangement allows the load to be equally distributed on the ropes. Any variation in the travel of the ropes around the compensating sheave



Equalizer for five compensating ropes

due to unequal groove tread diameter will be adjusted in the equalizer.

In the six-rope type of equalizer a third equalizer bar and sheave is added for the third pair of ropes. In very tall buildings the equalizer bars are replaced by sheaves and the compensating ropes are connected to a short piece of rope around the sheaves. This arrangement allows for a larger amount of adjustment of difference in the rope's travel than can be taken care of with the equalizing bars.

FROM AMONG READERS' PROBLEMS

Conducted by L. H. MORRISON

EFFECT OF INCREASING WEIGHT OF GOVERNOR BALLS—*Would increasing the weight of the flyballs of an ordinary corliss engine governor cause the engine to be regulated at a higher or a lower speed?* I.W.C.

In operation of the pendulum type of governor ordinarily employed on corliss engines, the arms from which the flyballs are suspended do not attain as great height as would be assumed by a simple revolving pendulum, because part of the centrifugal effort is employed in supporting a central weight, or in overcoming the elasticity of a spring, in addition to sustaining the weight of the balls and arms. Increasing the central weight, or, as it is known, adding load to the governor, acts as a greater restraint that results in increase of speed. The cutoff becomes longer because the balls are in lower position for the same speed, and increase of speed continues until the centrifugal effect becomes sufficient to carry the additional burden laid on the governor.

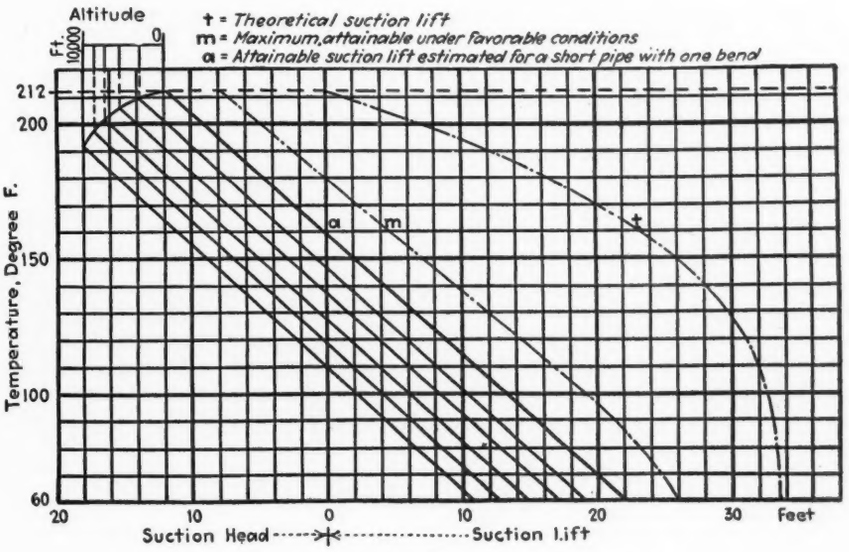
Evidently, the same result of speeding up the engine would result from making the governor balls lighter, but the reverse result is obtained either by taking load off the governor or by increasing the weight of the governor balls; that is to say, increasing the weight of the governor balls will result in slower speed of the engine.

SUCTION HEAD ON CENTRIFUGAL PUMP—*What is the head required on the suction of a centrifugal pump when handling water at 250 deg. F.* C.C.

The illustration shows the necessary head for temperatures up to 212 deg. F. The reason the maximum allowable head *m* does not agree with *t*, the theoretical, is that *t* is the height of the water column that will be supported by the atmosphere when a perfect vacuum exists above the column.

At 60 deg. F. the atmosphere will support 32.8 ft. of water. At 150 deg. F. there is a water-vapor pressure of 3.7 lb. abs., equivalent to 6.5 ft., instead of but 0.6 ft. when at 60 deg. F. Consequently, if the water is at 150 deg. F. the suction column cannot exceed 32.8 − (6.5 − 0.6) = 26.9 ft. Other slight corrections bring the value to 26 ft., as shown by the curve.

But if the pump is to lift water, the latter must be given a velocity, which entails a loss equivalent to some number of feet. To this must be added an entrance loss and a frictional loss. These reduce the water column to the value given by the curve *m*. At 212 deg. F. the water-vapor pressure equals the atmospheric pressure, namely, 14.7 lb. per square inch, so the theoretical lift is zero. To offset the losses mentioned, the curve line *m* shows that you need an 8-ft. pressure head.



Suction head needed by a centrifugal pump

At 250 deg. F. the water-vapor pressure is 29.82, lb. abs., or 29.82 − 14.7 = 15.12 lb. above atmospheric. This is equivalent to a positive suction head of approximately 34.5 ft., to which must be added the 8 ft. of losses, making a total of 42.5 ft. positive head needed by the suction pump under the best conditions. To this should be added a few feet to insure complete filling of the suction pipe.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

WE NEED 10,000 lb. of process steam per hour at 45 lb. in a part of our mill located 1,000 ft. from the power house. Would it be more economical, considering pipe and insulation costs, to transfer it at 200 lb. or at 45 lb.?

C. P. S.

PIPING COSTS vary with localities and erection facilities. In my experience, the installed cost of a 1,000-ft. line erected complete with necessary supports, with standard fittings and with standard thickness 85 per cent magnesia covering would run $1,890 for 3-in. pipe, $2,490 for 4-in. pipe, $3,280 for 5-in. pipe and $4,020 for 6-in. pipe. The pipe thickness for either 45 or 200 lb. would be standard, but the fittings would be standard cast iron for the former and extra heavy cast iron for the latter. The extra heavy fittings would add about 10 per cent to the above costs.

If the pressure is reduced from 200 lb. at the boiler house, the reduced pressure must be high enough to take care of transmission pressure drop under peak-flow conditions, which I judge from the question to be 10,000 lb. per hour; yet the pressure must not be too high, else the increased temperature at low flows might affect the quality of the product heated by the process coils. A reduced pressure of 50 lb., allowing a 5 lb. drop, would be a practical value. A 1,000-ft. line with fittings would probably give a pressure drop equiv-

alent to 1,200 ft. of straight pipe. The size of line for a pressure drop of .4 lb. per 100 ft. can be obtained from charts such as have appeared in *Power* from time to time, or can be calculated, and will be found to be 6 in. The cost for 45 lb. transmission would, therefore, be $4,020.

For transmission at 200 lb, 15 lb. pressure variation either side should be allowed for fluctuation in boiler pressure. A further 25 lb. should be allowed for proper reducing valve control at the mill, leaving 115 lb. for transmission pressure drop. In a manner similar to the above it will be found that a 3-in. line is required. This would cost $1,890 plus 10 per cent, or $2,080.

The question might arise as to whether insulation thicker than standard will be necessary on the 200-lb. line. The answer is dependent on plant steam cost and desired return on money invested. In the plants with which I am connected, standard thickness only would be used. Double standard thick covering would add $1.02 per foot to the 3-in. line costs, making a total of $3,010.

I think it would be more economical to transmit at 200 lb. if piping and insulation costs only are considered. However, unless a surplus of power is already available from back-pressure operation, it would be found that, if 10,000 lb. per hour of steam flow were available for any length of time, about 140 kilowatt-hours could be produced through bleeding or by a back-pressure unit at a cost of probably under ½c. per kilowatt-hour and at a saving of over ½c. per kilowatt-hour. For a 24-hr. day and a 300-day year this would result in over $5,040 saving, making 45 lb. transmission the economical solution of the problem.

Rochester, N. Y. L. J. SFORZINI.

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IN answering the question asked, the following assumptions have been made: (1) that standard weight pipe with extra heavy cast-iron flanges would be used for either 200 or 45-lb. steam pressure; (2) the heat insulation would consist of 1 in. thick 85 per cent magnesia covering with a canvas jacket in both cases; and (3) the fuel cost of steam is equivalent to 30c. per 1,000,000 B.t.u.

The costs for labor and material are based on average prices and may vary slightly according to local conditions, but will be satisfactory for the purpose of comparison.

It would be necessary to install a 4-in. line to transmit 10,000 lb. of steam per hour at 200 lb. per square inch pressure. With this size of line the pressure drop in the 1,000 ft. of pipe would be 15 lb. per square inch. The total cost of installing this line complete with insulation and jacket would be approximately $1,980. The annual loss due to radiation from this line would be $560.

A 6-in. line would be required to transmit 10,000 lb. of steam per hour at 45 lb. per square inch pressure, and the pressure drop would be 7 lb. per square inch in the 1,000 ft. of line. The total cost of installing this line complete with insulation and covering would be approximately $4,550. The annual loss due to radiation would be $475.

It is therefore evident that it would be more economical to transmit the steam at 200 lb. per square inch and reduce the pressure at the process end of the line, since the cost of a line to transmit it at 45 lb. per square inch would be approximately $2,500 more, with an annual saving in heat equivalent of only $85.

R. T. VAN NESS,
Industrial Engineering Div.,
E. I. DuPont de Nemours & Co.
Wilmington, Del.

A Question for Our Readers

WE USE a 125-kva. generator direct connected to a single-valve automatic engine in our laundry. The voltage varies so much that the lights dim, especially when one of the induction motors is thrown on the line. How can this trouble be remedied? C.C.

Suitable answers from readers will be paid for and published in the Jan. 7, 1930, issue.

A SIX-INCH pipe will be required at 45 lb., whereas a four-inch pipe is sufficient at 200 lb., to transmit 1,000 ft. if a 5 per cent drop is assumed.

For the same insulation thickness, the six-inch pipe will require 1½ times the insulation needed for a four-inch pipe. For the same insulation cost the four-inch pipe can be covered to a 50 per cent greater thickness. This additional pipe covering will more than take care of increased radiation due to a higher temperature in the four-inch pipe.

Hence the determining factor is the cost of the pipe. Since four-inch pipe is cheaper to buy and to install, it will be more economical to transmit the steam at 200 lb. and then reduce the pressure to 45 lbs. GORDON R. HAHN.
Westfield, N. J.

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IN supplying steam to process in a building situated 1,000 ft. from the power house, it is decidedly more economical to carry the boiler pressure the whole distance, and then reduce to the desired low pressure near the point of use.

To carry 10,000 lb. of steam per hour for the required distance at 200 lb. pressure a 3-in. pipe will suffice, with a 3-in. reducing valve expanding into a 5-in. distribution main. To carry the same quantity of steam over the same distance at 45 lb. pressure, takes a 5-in. pipe. Moreover, if the reducing valve were placed in the power house, allowance would have to be made for pressure drop in the 5-in. line. This would vary according to the rate of condensation in the 1,000-ft. line, which would not be constant. Consequently, better and closer regulation would be obtained by placing the reducing valve in the process building.

The saving to be made consists of 1,000 feet of smaller piping, less insulation and less radiation loss, despite the 95 deg. higher temperature of the steam at 200 lb. pressure.

Moreover, the question of returning the condensation to the power house enters into the problem. An efficient steam separator should be placed ahead of the reducing valve. The condensation from process would drain to a three-valve pumping trap. The drip of the steam separator can be used for the operating pressure, the trap vent being connected back into the low-pressure system. A 1½-in. return line from the trap discharge would be carried back to the power house in the same insulation as the 3-in. supply line, and the condensation returned, if possible, direct to the boilers with a return trap.

I have made two such installations and they have shown considerable economy in operation and a remarkably small loss of useful heat.

H. L. PEILER,
Mason Regulator Co.
Montreal, Can.

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SINCE the specific volume of steam at 45 lb. is about 7.2 cu.ft. per pound and at 200 lb. is about 2.3 cu.ft. per pound, the sizes of pipe necessary to carry the 10,000 lb. of steam per hour will be proportional to these specific volumes. Thus if a 4-in. standard pipe is necessary for 45 lb., then a 2½-in. extra-strong pipe would be ample for 200 lb., assuming the same steam velocity in each case.

The weight of 2½-in. pipe is approximately 30 per cent less than that of 4-in. standard pipe, and the cost of each is proportional.

The cost of insulation would be less for the smaller pipe, after taking into consideration the higher temperature at 200 pounds.

If steam is transferred at 200 lb. it will, of course be necessary to reduce the pressure to 45 lb. after transmission, which would require a reducing valve. If the process is one in which the temperature must be fairly exact, the 200-lb. pressure will assure ample temperature, whereas the 45-lb. pressure might vary somewhat in transmission.

Taking all these factors into consideration, it appears more economical to transfer the process steam at 200 lb. pressure.

E. F. GRAHAM,
Central and Southwest Utilities Co.
Dallas, Texas.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

*Spot * News*

WITH NO RELIEF IN SIGHT *for the unprecedented drought which has prevailed in the Pacific Northwest, tentative plans have been drawn for the rationing of electricity under a power administrator to be appointed by Governor Hartley of Washington. Hope of pooling power resources to tide over the emergency faded when a canvass of all generating stations in the state showed that there was no surplus power available.*

* * *

OF THE $50,000,000 BUDGET *for* 1930 *of the Aluminum Company of America,* $12,000,000 *will be expended for the development of power needed in the production of pig aluminum, according to a recent statement of the company.*

* * *

A NEW FUEL *for combustion engines, based on a secret process that mixes gasoline with water is being developed by Prof. W. Harold Taylor, of the University of Buffalo, and a group of Buffalo chemists. The new mixture is said to give higher compression than ordinary gasoline fuels.*

* * *

SALES *of industrial power for the first nine months of 1929 reached a record total of 34,250,000,000 kw.-hr., an increase of 4,120,000,000 kw.-hr., or 13½ per cent, over the corresponding period of last year, according to a statistical report just made public by the N.E.L.A.*

* * *

SENATORIAL INQUIRY *is expected as a result of the action of F. E. Bonner, executive secretary of the Federal Power Commission, proposing to transfer a large share of the accounting work of the commission to the War, Interior, and Agriculture departments.*

* * *

A NEW OUTPUT RECORD *for a single month was established by the New England Power Association with the generation of 161,847,000 kw.-hr. in October. This is 19 per cent over the output of the association in October, 1928, and 63 per cent over that of October, 1927.*

Program Announced for A.S.H.&V.E. Meeting at Philadelphia, Jan. 27-31, 1930

Importance of Heating and Ventilating to Modern Life and Progress Made During Year to Be Stressed at Technical Sessions and International Exposition of Equipment

AN EXCEPTIONAL program has been prepared for the 36th Annual Meeting of the American Society of Heating & Ventilating Engineers, to be held in the Benjamin Franklin Hotel, Philadelphia, Jan. 27-31, 1930, and it is anticipated that the largest attendance ever recorded at a function of that society will be present when President Thornton Lewis calls the first session to order. After an eight-year absence the society will again enjoy the hospitality of Philadelphia, and the local chapter members, under the capable leadership of John Cassell, honorary chairman and R. C. Bolsinger, general chairman, are co-operating to make this meeting a great event.

The first official function will be the meeting of the council on Monday, Jan. 27, and during the day a series of conferences of technical committees will be held. The first general meeting will be opened by President Lewis at 9:30 a.m. Tuesday, Jan. 28, and on succeeding days morning sessions will be held in the Benjamin Franklin Hotel and afternoon sessions, beginning at 2:30 p.m., will be held at the Commercial Museum, where the First International Heating and Ventilating Exposition is to be open during the entire week of Jan. 27 to Feb. 1.

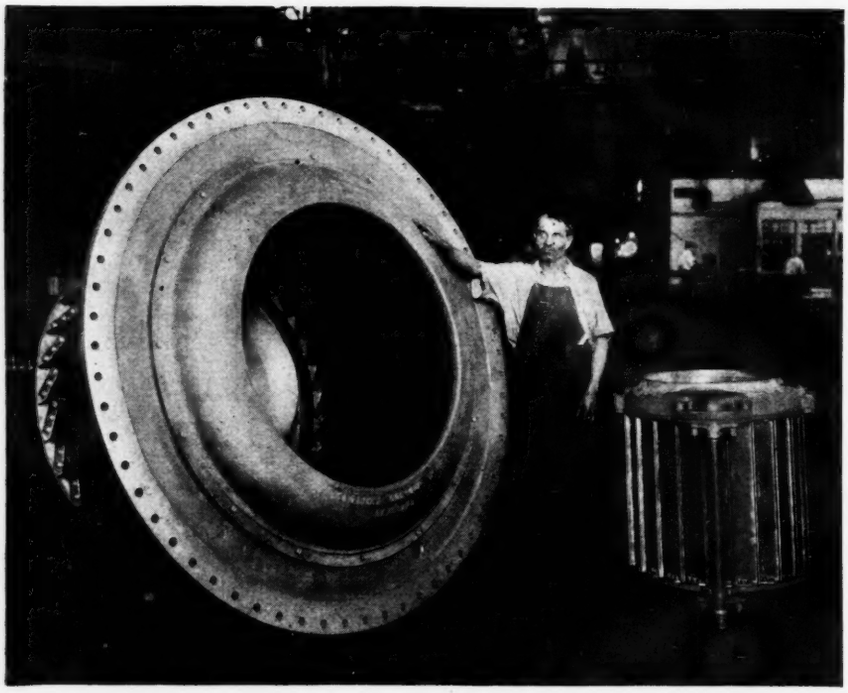
With the combined attractions of a varied technical program, a large exhibition of modern equipment and a series of unusual social functions, there is a unique opportunity for members and their friends to spend a most enjoyable time in Philadelphia.

The program committee, composed of H. H. Angus, chairman, A. J. Nesbitt and Prof. F. B. Rowley, has made an early start and announces a tentative list of subjects proposed for discussion at the seven technical sessions, among them being: "Electric Power Generation by Process Steam," by L. A. Harding; "Air Conditioning of the United States Capitol," by L. L. Lewis and A. E. Stacey; "Welding of Pipe for Heating System," by F. W. Johnson; "Automatic Controlling Devices for Heating System," by F. I. Raymond; "Electric Heating for Homes, Factories and Other Buildings," by W. S. Scott; "Measurement of the Flow of Air Through Registers and Grilles," by Davis.

A feature of the meeting will be the International Heating and Ventilating Exposition to be held during the entire week at Commercial Museum. Here a record of the industry's activities and progress will be presented. Products to be shown include every type of equipment used in heating and ventilating; the boilers and furnaces in which combustion is performed, equipment using air, water or other heated fluids for the transfer of heat; systems used to distribute the heat; and the radiators for diffusing it to create comfort. Refractories, insulating materials, blowers, fans, air-conditioning and humidifying equipment, pipe and piping systems, pipe fittings, unit heaters and all the control and regulating apparatus and instruments used at any stage in the generation of heat, cooling and ventilating, will be on display.

For the social part of the program some of the time-honored customs will be observed, and several novel features have been added. As usual, the officers and council will entertain the authors of papers at luncheon on Monday. The past presidents will have their annual dinner, and while they are dining their wives will have a special dinner party. A special program for the ladies in attendance is in charge of M. C. Gillett. The major social event will be the annual banquet and dance, at which the presentation of the past presidents will then be made. Several surprises are promised at this dinner. Time has been allotted not only for a visit to the exposition but also for side trips and tours of inspection. Bus service has been arranged for between the hotel and the Commercial Museum, so that members can go to sessions or to see the exposition at any convenient time.

Historical and educational exhibits showing the progress of heating and ventilating are being sought by the management of the exposition. A special section is being set aside for the purpose of making the exhibit one of the most complete and comprehensive ever gathered together. An appeal is not only being made to those within the industry but to the laity for information which will lead to the securing of both historical and educational exhibits for the exposition.



SHIPPED recently to a large alkali works by the Centrifix Corporation this 42-in. size (the larger of the two units shown) is the largest centrifugal-type internal separator ever built for evaporator service.

Battersea Now Under Way; Fumes Problem Solved

Information concerning progress with the work of constructing the huge new electric power station at Battersea, London, is contained in the announcement just made that a contract for the supply of the structural steel work for the first section of the station has been placed by the London Power Company; and also in the report of the London County Council Public Health Committee on the discussion which its deputation had recently with the Ministers of Health and Transport.

The Minister of Health informed the deputation that building had already commenced and that there could be no question now of stopping it. He said he did not believe there was any real divergence in view between the government and the council on the Battersea project. All are anxious that new industrial plants such as the Battersea station shall be erected with a view both to efficiency and the prevention of nuisance.

The London Power Company appointed experts to examine the possibility of overcoming the nuisance caused by sulphur fumes, and stated that they had been successful in discovering a method of preventing the nuisance.

In this connection it is interesting to note that David Brownlie, in the course of a recent lecture on steam-driven power practice before the Glasgow section of the Institution of Mechanical Engineers, discussed the question of sulphur in chimney gases. Arising out of the litigation in which the Manchester Corporation has been involved concerning the Barton power station and the uproar against the Battersea station, he declared that most large coal-burning installations would have to take measures to mitigate to a considerable extent the trouble arising from sulphur.

A station burning 1,000 tons of coal a day will discharge the equivalent of 13.5 tons of sulphur, or 41.3 tons calculated as sulphuric acid. With low-temperature carbonization, however, a large proportion of the total sulphur, probably in average cases well over 50 per cent, is driven off in the gases and vapors, and is easily removed by washing. If, therefore, coal of normal quality is used in the washed condition to reduce the pyrites content, submitted to low-temperature carbonization, and the gas washed, probably in average cases about 65-75 per cent of the sulphur would be removed.

This new problem also emphasizes the many claims for the principle of submitting the raw coal to combined low-temperature carbonization and total gasification, condensing the tar, scrubbing the light oils, and removing the whole of the sulphur from the gas, which could then be burnt under the boilers in place of solid fuel. In this way sulphur in the chimney gas would be eliminated, and also smoke, grit, and dust. Alternatively, the coal could be submitted to combined low-temperature carbonization and partial gasification only, with the gas and the solid fuel burnt under the boilers, and the sulphur reduced, as before by, say, 65-75 per cent.

Progress Reported by Heat Committee

Extensive criticism of the test code covering insulation in the building and low-temperature field has been received by the Committee on Heat Transmission of the National Research Council, according to the latest progress report of the committee. This code is now being revised, and the committee hopes to have it printed in final form within the next two months.

The report also states that the test code covering insulation in the steam and moderate-temperature fields has been criticised and is now being revised to meet the objections raised. Experimental work is in progress dealing with the thermal conductivity of electrical insulation, with a view to establishing standards for cable insulation.

Necessary data for the "Directory of Experimental Research in Educational Institutions of the United States" have been received by the committee. The director, W. V. A. Kemp, is editing the material for the second edition of the directory, which will be issued in the near future. The text on another book, "The Promotion of Heat Transfer," being prepared for the committee by Prof. W. H. McAdams, is progressing in excellent shape, according to the report. Professor McAdams collected extensive data for this treatise during the summer months.

Fairbanks, Morse Strikes Snag in Idaho Sale

Application for writ of prohibition has been made by a taxpayer of Buhl, Idaho, in the Supreme Court of that state, to prohibit the City of Buhl from contracting with Fairbanks, Morse & Company for the installation of a Diesel engine generating system, to be paid for on what is known as the "pledge order" system, whereby payments are made out of operating revenues.

For some time the city has been considering the possibility of entering the power business through the installation of a Diesel engine generator to be purchased from Fairbanks, Morse & Company. In 1928 a proposition to install such a system was defeated by a vote of the people. In the early fall of 1929 negotiations with the city were reopened by the company to determine whether a city in the State of Idaho would be permitted to enter the power business without the approval of the qualified electors.

The Idaho Power Company, Boise, an intervenor in the case, points out that Fairbanks, Morse & Company will hold title to the property installed until the contract of purchase has been entirely completed, and contends that this fact constitutes Fairbanks, Morse an electrical utility within the Idaho statutory definition of that term, which would make it necessary for that company to seek from the Public Utilities Commission a certificate of convenience and necessity.

Business Leaders Confer With U. S. Chamber

Representatives of 32 manufacturing and distributing groups, constituting in large degree the warp and woof of the national business fabric, met at the United States Chamber of Commerce headquarters in Washington, D. C., on Dec. 5, to consider, at the request of President Hoover, measures looking to the maintenance of business activities at their present high levels. Approximately two hundred business men occupying key positions in trade organizations were invited to appear for their various lines of activity. In addition to these, a number of individual business men of recognized authority in the field of practical economics attended the conference.

President Hoover opened the meeting, and Secretary Lamont and Assistant Secretary Klein, of the Department of Commerce, and several other government officials were present. Measures dealing not only with the immediate situation but also with future problems involved in the preservation of the normal economic balance were discussed. The fact was stressed that no marked weakness is evident in the present business situation, but, on the contrary, surprising strength is shown, due in a large measure to wise practices followed in the past few years.

Among the business men in attendance at the conference were Howard Coonley, president, Walworth Company; Malcolm Muir, president, McGraw - Hill Publishing Company; Charles Piez, chairman of the board, Link-Belt Corporation; H. T. Richardson, president, Institute of Boiler & Radiator Manufacturers, and Gerard Swope, president, General Electric Company.

Henry Ford Presented With Electrical Exhibit

One of the most complete exhibits of pioneer electrical inventions in existence was recently presented to Henry Ford for his museum at Dearborn, Mich., by the Westinghouse Electric & Manufacturing Company. Approximately 600 different articles comprised the exhibit, the majority of them being important inventions of the "gay eighties and nineties" that were developed for the most part by Westinghouse engineers.

Included in the exhibit are many early Gaulard and Gibbs transformers, the product of the genius of an erratic inventive Frenchman and his wealthy sporting English teammate. It was from this pair that George Westinghouse acquired patents for alternating-current transformers. There is also one of the first alternating-current transformers built in the United States, which was developed by the famous Stanley at his Great Barrington, Mass., laboratory in 1885. This equipment antedates all other alternating-current units.

There are also an old-fashioned steam engine and its "alternator," which produced some of the first commercial alternating current, and the first Tesla motor, whose induction principle made possible the present day world-wide application of electric power. Next in importance are the famous pioneer induction meters, perfected by Shallenberger and his associates, the first practical alternating-current meters and the forerunners of all present day metering instruments.

Ninety Lunch Inside Boiler

NINETY men, including foremen and skilled laborers, who had a part in constructing the three huge boilers recently installed in the East River Generating Station of the New York Edison Company, attended on Dec. 2, a luncheon served inside Boiler No. 9, the newest of the three. The guests were seated on a platform 43 ft. 6 in. long by 23 ft. 6 in. wide, which was burned as soon as they left. Speeches were made by Matthew S. Sloan, president of the company, and other officials.

Immediately after the luncheon Boiler No. 9 was fired, marking the completion of this new installation to the Edison company's system. The other two boilers have been in service for several weeks, and with the placing in operation of the third full capacity of the 160,000-kw. generating unit became available. Details of this installation were given on page 777 of the Nov. 12 issue of *Power*.

All Nations Except Mexico Gain in Oil Production

All major petroleum producing countries showed increases in production in 1928 over 1927 with the single exception of Mexico, whose output declined from 64,121,000 bbl. in 1927 to 50,150,000 bbl. in 1928, or 21.79 per cent, according to figures made available recently by the minerals division of the Department of Commerce.

While the United States produced more oil in 1928 than during any previous year, with a total of 902,000,000 bbl., this was an increase over 1927 of only .09 per cent, the figures showed.

Venezuela, the second largest producer, increased its output from 63,134,000 bbl. in 1927 to 106,000,000 in 1928, or 67.90 per cent. According to consular reports, Venezuela produced 78,000,000 bbl. during the first seven months of 1929.

Russia's production of 87,800,000 bbl. in 1928 represented a gain of 14 per cent, while Rumania, with 30,600,000 bbl., had an increase of 16.05 per cent.

News of Canada

Lievre River Development Nearing Completion—Riviere des Prairies Dam Enormous—West Kootenay to Start Construction Soon — Island Falls Project Rapidly Progressing

ONE of the largest power development projects in eastern Quebec is rapidly taking shape on the Lievre River at Buckingham, about 30 miles from Ottawa. A huge dam is being built across the river and when this is completed next year, a total of 120,000 hp. will be developed by the MacLaren Company, of Buckingham. Later on a second development of between 30,000 and 40,000 hp. will be undertaken, and a third site which engineers of the company have located on the river is capable of producing another 120,000 hp., making a possible and likely development of 270 000 horsepower.

Riviere des Prairies Project

Some idea of the magnitude of the Montreal Island Power Company's new undertaking on the Riviere des Prairies, seven miles from the heart of Montreal, may be gained from the following figures: 112,000 tons of earth was removed in preparing for the various structures; 111,000 tons of rock was excavated from the river bed and banks; 276,000 tons of concrete was used in the dam and protective walls; 1,900 tons of steel was used in the power house and gate structure; and a million bricks were used in the building walls. The plant is designed for an ultimate development of 120,000 hp. Six generating units comprise the initial installation, each capable of producing 12,000 horsepower.

West Kootenay Plans

Prospects are that the West Kootenay Power Company will have under construction, by early spring, power and storage development projects in British Columbia that will represent a total capital expenditure of nearly $4,000,000. Lorne A. Campbell, vice-president and general manager of the company, stated that he expects to see work begun on the Adams River power project by spring and that work will start at the Granite Dam site on the Kootenay River by the middle of December. Rough estimates of the capital expenditure involved at these two sites are: Adams River, $2,500,000; Granite storage dam, $1,250,000. Although the final order for the Granite storage scheme has not yet been given, the company has obtained permission to proceed with rock excavation.

Progress at Island Falls

It has been officially announced that power from the new Island Falls development on the Churchill River in Northern Manitoba will be available for operation of the Flin Flon mine of the

Hudson Bay Mining & Smelting Company in October, 1930. The concrete block superstructure of the power house has been completed and the generating equipment is to be delivered in January of next year. Progress on the transmission line from Island Falls to Flin Flon is well under way, and completion is expected by July of next year. The Island Falls plant will consist of two 1,500 hp. and three 14,000 hp. units. Provision has been made in the plant to double this capacity with comparatively small expense, as only the turbines and generating equipment will have to be added.

New Refractories Tested for Baffles and Doors

By mixing Lumnite, a building cement, with Plibrico, a high-temperature refractory cement, two new refractories for use on furnace baffles and door linings have been developed recently. Tests conducted at the Mellon Institute of Industrial Research under the direction of Stuart M. Phelps demonstrated that where low temperatures are encountered the addition of Lumnite increases the serviceability of Plibrico for this use.

In the tests four different mixtures of Lumnite and Plibrico were prepared together with specimens of each alone. The pyrometer cone equivalent test was run on four-inch cubes, and load tests were made on standard nine-inch bricks. Results showed that as the percentage of Lumnite in the mixture increased, the pyrometric cone equivalent was lowered, but the strength under load was increased up to the fusing point of the mixture. Plibrico alone gave the highest pyrometric cone equivalent, whereas Lumnite gave the lowest.

It was also evident from the tests that Plibrico begins to bake long before Lumnite begins to fuse. Tests of cubes made of the mixtures with one face exposed show all of them to be of satisfactory strength up to a temperature of 2,500 deg. F. In his report Mr. Phelps stated, "It will be noted from these data that the higher the percentage of Lumnite, the stronger the cube at low temperatures. As the temperature increases, however, the straight Plibrico reaches the same strength as the mixture and, of course, is more refractory."

European Hydro Development May Affect Coal Trade

The effect of steadily increasing water-power developments upon the coal industry in general is a matter of great contemporary interest in Europe, the Department of Commerce announced recently.

The development of domestic hydroelectric resources is perhaps the principal economic policy of France, and certainly the program initiated in that country in 1915 is ambitious, according to Trade Commissioner Thomas Butts, Paris. Important plants also are under construction or projected in Italy and Spain. While American exports of coal to these countries are small, except during abnormal periods in the international coal trade, the subject may be of interest to United States coal exporters, since the restriction of the French Italian, and Spanish markets doubtless would cause British exporters to increase their efforts to sell in other foreign markets.

Electrical power developments, whether from water power or other sources of energy, have been prompted, among other reasons, by the hope of reducing imports of fuel, both for the sake of improving the balance of trade and to release railroad equipment for other services. They have been stimulated by shortage of labor and the consequent need of increasing the use of mechanical equipment, as well as by a desire to check the drift of population to the cities and to maintain cottage industries. An additional object has been the strengthening of national defense in countries with insufficient supplies of coal.

Rehabilitation and natural expansion of industry in these countries since the war has further enhanced the development of power generating projects in Europe.

Coming Conventions

American Society of Mechanical Engineers. Fiftieth Anniversary Celebration at New York City, Hoboken, N. J., and Washington, D. C., April 5-9, 1930. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

International Heating & Ventilating Exposition. Commercial Museum, Philadelphia, Pa., Jan. 27-31, 1930. Manager, C. F. Roth, Grand Central Palace, New York City.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Marine Engineers' Beneficial Association. Annual convention at Hotel Barlum, Detroit, Mich., the week of Feb. 10, 1930. Secretary, A. L. Jones, 9th St. and Mount Vernon Place, N. W., Washington, D. C.

PERSONALS

ELMER A. SPERRY, retired president of the American Society of Mechanical Engineers and head of the American delegation to the World Engineering Congress, held in Tokio recently, has been decorated by Japan with the Order of the Sacred Treasure, second class, in recognition of his services in the cause of Japanese-American friendship.

DR. ING. E.H. OSCAR VON MILLER, honorary president of the Second World Power Conference, to be held at Berlin, Germany, in 1930, and director of the famous Technical Museum at Munich, was tendered a dinner by the American Committee of the World Power Conference on Dec. 7 at the Metropolitan Club in New York City.

ROY F. BURKHART, for the past two years electrical engineer in the operation and maintenance department of the United Gas Improvement Company of Philadelphia, Pa., has recently accepted a position as engineer in the electrical division of the Stone & Webster Engineering Corporation at Boston.

JOHN E. S. THORPE, formerly general superintendent of the Knoxville Power Company, Calderwood, Tenn., has been appointed president of the Nantahala Power & Light Company, Bryson City, N. C.

WILLIAM M. WHITE, chief engineer of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., is chairman for 1930 of the Hydraulic Division of the American Society of Mechanical Engineers, and Byron E. White, general engineer of the Utica Gas & Electric Company, Utica, N. Y., is secretary.

PAUL A. SCHOELLKOPF, chairman of the Buffalo, Niagara & Eastern Power Corporation, has been elected president of the Niagara Hudson Power Corporation to succeed Ray P. Stevens, who resigned. Mr. Stevens is president of Stevens & Wood, Inc., engineers, and the American Electric Power Corporation.

JOHN VAN BRUNT, vice-president of the Combustion Engineering Corporation, is chairman of the Fuels Division of the American Society of Mechanical Engineers for 1930.

MATTHEW S. SLOAN, president of the New York Edison Company, was made the recipient of the honorary degree of doctor of engineering Nov. 23 by the Alabama Polytechnic Institute, his alma mater. The degree, which was conferred by President Bradford Knapp, was received by Mr. Sloan on the same platform in old Langdon Hall where he was awarded his first college degree, 28 years ago.

Business Notes

Oster Manufacturing Company, Cleveland, Ohio, and Williams Tool Corporation, Erie, Pa., have recently effected a merger. R. B. Tewksbury, formerly president of the Oster company, is president of the new combine.

General Refractories Company, Philadelphia, Pa., announces the appointment of Paxson Taggart Company, Luzerne and D Sts., Philadelphia, and Bison Builders Supply Company, 1345 Genesee St., Buffalo, N. Y., as exclusive dealer representatives for its high-temperature cements.

Francis R. Wadleigh, consulting mining and fuels engineer, and Ernest L. Bailey, mining engineer, announce their association for the purpose of rendering a complete consulting and engineering service to the coal mining and fuel consuming industries.

Lincoln Electric Company, Cleveland, Ohio, announces that Lockwood Hill, for the last ten years a member of the Blackman Hill Company, has organized a new company known as the Hill Equipment Engineering Company with offices at 4620 Delmar Blvd., St. Louis, Mo. The new organization will have the exclusive sale of the products of the Lincoln company.

George W. Akers Company, Detroit, Mich., announces that W. H. Kuhn, formerly chief engineer of the Wright-Austin Company, is now in charge of its industrial sales.

Electric Power Equipment, Ltd., is the new name of Bartholomew, Montgomery & Company, Ltd., 510 West Hastings St., Vancouver, B. C. F. J. Bartholomew, head of the firm, has announced that the sole purpose in changing the name is to have it define the activities of the company.

Trade Catalogs

Valves—Angle gate, check, lever and a host of other valves are described in a 257-page catalog, No. 61, just issued by the Chapman Valve Manufacturing Company, Indian Orchard, Mass. Well illustrated by diagrams, tables and photographs, the catalog is attractively bound in limp leatherette. A supplementary publication of the same company gives extensive data on sluice gates, shear gates, flap and mud valves, foot and vertical check valves.

Hoists—Numerous applications of Shepard electric hoists are described and illustrated in an attractive 36-page booklet recently published by the Shepard Niles Crane & Hoist Corporation, Montour Falls, N. Y.

Traps—The McAuley Super-Trap for steam, gas and compressed air is fully described in an illustrated folder recently issued by the McAuley Automatic Trap Company, Imperial Power Building, Pittsburgh, Pa.

Auxiliaries—Schutte & Koerting Company, 12th and Thompson Sts., Philadelphia, Pa., has just published Booklet No. 1, which illustrates in condensed form its equipment for steam power plants. This 28-page bulletin contains much interesting information on auxiliaries.

Conveyors — "Rex Power Plant Equipment" is the title of an illustrated folder just issued by the Chain Belt Company, Milwaukee, Wis., covering its equipment for the power plant and central station fields.

Furnaces—The Stratton Vertical Jet principle of combustion, which burns crushed coal in suspension smokelessly and without fly ash, is fully described in a bulletin issued by the Stratton Engineering Corporation, 116 East 18th St., New York City.

Pumps—An illustrated folder just issued by the Penberthy Injector Company, 1242 Holden Ave., Detroit, Mich., contains a description of automatic cellar drainers and electric sump pumps.

Motors—A very complete catalog, No. B-829, just published by the Ideal Commutator Dresser Company, Sycamore, Ill., contains, among other things, a brief history of commutator maintenance; a special chapter on the operation of direct-current generators; an analysis of commutator troubles and their remedies; tables on fusing, wiring and full-load current data, besides many other tables of practical value to every electrical engineer, and detailed data on many different tools and machines used in power and industrial plants.

With the Society Sections

A.S.M.E., Ontario Section. Meeting, Dec. 11, Galt, Ont., at 7:30 p.m. Subject: "Vertical Air Compressors," by Georg Oman of the Babcock-Wilcox & Goldie-McCulloch Company. A trip through the Babcock plant in the afternoon and dinner in Galt will precede the address in the evening.

Boston Society of Civil Engineers. Buffet supper and meeting, Dec. 18, at 6:15 p.m., at Tremont Temple. Subject: "Hydraulic and Mechanical Features of the Bellows Falls Hydro-Electric Plant," by Edwin A. Dow, designing engineer of the New England Construction Company.

New England Water Works Association. Regular monthly meeting and luncheon, Dec. 11, at 1 p.m., at the Boston City Club. Subject: "Changes in Power Pumping at Newport, R. I.," by Harold Watson, Newport Water Works; and "Marshfield Pumping Plant," by Fred O. Stevens, of Symonds & Stevens, consulting engineers, of Boston.

Boston Plant Engineers' Club. Meeting and dinner, Dec. 18, at 6:30 p.m., the University Club. Subject: "Design and Lubrication of Bearings," by Prof. Arthur E. Norton, of Harvard Engineering School.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.15 @$2.50
Kanawha	Columbus	1.30 @ 1.60
Smokeless	Cincinnati	2.00 @ 2.25
Smokeless	Chicago	2.00 @ 2.25
S. E. Kentucky	Chicago	1.30 @ 1.60
Steam	Pittsburgh	1.50 @ 1.80
Gas Slack	Pittsburgh	1.00 @ 1.15
Big Seam	Birmingham	1.25 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$3.00
Barley	New York	1.35@ 1.50

FUEL OIL

New York—Dec. 3, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Nov. 27, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.595916 per bbl., or 42 gal.; 26@28 deg., $1.645916 per bbl.; 28@30 deg., $1.695916 per bbl.; 30@32 deg., $1.745916 per bbl.; 32@36 deg., gas oil, 4.651c. per gal.; 37@40 deg., distillate, 5.73c. per gal.

Pittsburgh—Nov. 20, f.o.b. local refinery, 30@34 deg., fuel oil, 4.87½c. per gal.; 36@40 deg., 5.12½c. per gal.

Philadelphia—Nov. 23, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Nov. 26, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Nov. 23, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., $1.02½@$1.07½ per bbl.; 30@32 deg., $1.22½ per bbl.

Boston—Nov. 25, tank-car lots, f.o.b., 12@14 deg., Baumé 4.25c. per gal.; 28@32 deg., 5.5c. per gal.

Dallas—Nov. 30, f.o.b. local refinery 26@30 deg., $1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles—Dominguez Estate Co., is having preliminary plans prepared for a 12 story office building at Wilshire Blvd. between Cloverdale and Cochrane Sts. Estimated cost $1,500,000. Morgan, Walls & Clements, 1134 Van Nuys Bldg., are architects.

Calif., San Diego — Dept. of Public Works, Division of Architecture, Sacramento, will receive bids until Dec. 24 for the construction of a training school, including power house with stack 70 ft. high at State Teachers' College.

Calif., San Jose — Corporation being formed, c/o L. H. Shapiro, 68 Post St., San Francisco, plans the construction of an ice hockey rink here. Estimated cost to exceed $50,000.

Calif., San Pedro—Mutual Income Properties, Union League Bldg., Los Angeles, awarded contract for the construction of a 10 story cold storage terminal at O'Farrell and Sepulveda Sts., to R. Brown, 516 Union League Bldg., Los Angeles. Estimated cost $1,250,000.

Colorado—Public Service Co., C. N. Standard, Pres., 15th and Champa Sts., Denver, appropriated $4,500,000 to be expended in 1930 for extension to steam and hydraulic plants, relaying gas pipes, installing power lines and other improvements at Denver, Alamosa, Salida, Valmont, Boulder, Estes Park, Rifle, DeBeque, Fort Collins, Leadville and Brush. V. L. Board, 1515 East 8th Ave., Denver, is engineer.

Delaware and Pennsylvania — Delaware Power & Light Co. and Delaware Electric Power Co., plan to expend $2,862,000 during the coming year for new construction and improvements in their various properties. Plans include enlargement of Christina sub-station and Brandywine plant, $670,000; submarine cables under Delaware River and transmission lines on land to connect Wilmington system with new power plant under way at Deepwater Point, $730,000; new buildings, transformers, transmission and distribution lines $550,000, etc.

Mass., Dorchester (Boston P. O.)—Owner, c/o A. W. K. Billings, Jr., 80 Boylston St., Boston, Archt., is receiving bids for the construction of an ice plant here. Estimated cost $100,000.

Mass., East Boston (Boston P. O.)—Boston Ice Co., 11 Deerfield St., Boston, will receive bids about Jan. 2 for the construction of a 120 ton ice plant on Eagle St. here. Estimated cost $80,000. C. L. Wier, 13 East 37th St., New York, N. Y., is architect and engineer.

Mass., Lowell—Lowell Ice Co., Middlesex St., will not construct 1 story, 145 x 305 ft. ice hockey rink at Jackson and Middlesex Sts. $100,000. Project in abeyance.

Mass., Mattapan (Boston P. O.)—Hospital Dept., will soon receive bids for addition and alterations to boiler plant at Tuberculosis Hospital, River St. here. Estimated cost $190,000. J. H. Ritchie & Associates, 250 Stuart St., Boston, are architects.

Mass., Somerville (Boston P. O.)—Metropolitan Ice Co., 321 Washington St., awarded contract for additions and alterations to ice plant to Vappi & Ferguson, 515 Massachusetts Ave., Cambridge. Estimated cost $60,000.

Mich., Detroit—Public Lighting Comn., 174 East Atwater St., awarded contract for a 4 story office building and warehouse to Martin & Lraussman Co., 955 East Jefferson Ave. Steam heating system, etc., will be installed.

Mich., Traverse City—State Administrative Board, will receive bids until Dec. 30 for the construction of a 3 story hospital including detached power house on South Elmwood St. Estimated cost $1,194,000. Angell & Shreve, 1037 Book Bldg., Detroit, are architects.

Minn., Minneapolis—Nordie Hotel Assn., J. A. O. Stub, Pres., 1000 4th Ave. S., awarded contract for the construction of an 8 story hotel at Willow St. and Yale Pl., to O. P. Bailey Co., Guardian Bldg., St. Paul. Estimated cost $954,000. Steam heating system, etc., will be installed.

Minn., St. Paul—Horace Lowry, 1 South 11th St., Minneapolis, plans the construction of a 15 story office building including steam heating system, etc. at Wabasha St. between 4th and 5th Sts. here. Estimated cost $1,000,000. C. H. Johnston, 360 Robert St., St. Paul, is architect.

Mo., Campbell—City plans an election Dec. 17 to vote $20,000 bonds for extensions and improvements to light plant and distribution system. Russell & Axon, 6200 Easton Ave., St. Louis, are engineers.

Mo., Columbia—Missouri Survey Commission, recommended appropriation of $8,200,000, to be expended within ten years for a group of buildings, including heating and power plant, $150,000 etc. for Missouri University.

N. J., Allenhurst—Eastern New Jersey Power Co., 601 Bangs Ave., Asbury Park, awarded contract for addition to power plant here to T. A. Pullen, Norwood Ave., Deal. Estimated cost $50,000.

N. J., Jersey City—Journal Sq. Medical Building Inc., W. B. Quinn, Pres., c/o Harris & Sohn, 58 Park Pl., Newark, Archt., is having plans prepared for the construction of a 10 story office building including steam heating and ventilation systems at Sip and Tonnele Aves. Estimated cost $1,000,000.

N. J., Newark—St. Barnabas Hospital, 685 High St., is having preliminary plans prepared for the construction of a hospital, nurses' home, power plant, etc. on High St. Estimated cost $1,500,000. Cron, Lewis & Wiek, 200 5th Ave., New York, N. Y., are architects.

N. Y., Brooklyn—New York Times, 229 West 43rd St., New York, awarded contract for a 4 story newspaper plant on Third Ave. here, to J. Baird & Son, 101 Park Ave., New York. Estimated cost $1,000,000. Steam heating system, boilers, elevators, etc. will be installed.

N. Y., Glendale—Knickerbocker Ice Co., 41 East 42nd St., New York, will soon receive bids for the construction of a 54 x 85 ft. ice plant at Proctor St. and Edsall Ave. here. C. L. Weir, 13 East 37th St., New York, is architect.

N. Y., New York—Holler Ice Mfg. Co., Reeds Mill Lane and Hollers Ave., will build an 80 x 150 ft. ice plant. Sibley & Featherstone, 205 East 42nd St., are architects. Work will be done by day labor and separate contracts.

N. C., Wilson — City passed ordinance authorizing $300,000 bonds for extensions and improvements to municipal power plant.

O., Cincinnati — Hamilton County Commissioners, Hamilton County Courthouse, will receive bids until Dec. 20 for alterations and additions to power and laundry building including boilers, stokers, coal handling system, etc. at Hamilton County Tuberculosis Sanatorium, Guerley Rd.

Okla., Marlow—City plans an election Dec. 10 to vote $60,000 bonds for the construction of a new soft water supply system including wells, pumps, etc. V. V. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Okla., Oklahoma City—J. J. Harder Inc., Trades National Bldg., is having preliminary plans prepared for the construction of a 130 x 200 ft. cold storage warehouse on Reno St. Estimated cost $350,000. Private plans.

Pa., Pittsburgh — Gulf Refining Co., Frick Bldg., is having plans prepared for the construction of a 34 story office building at 7th and Grant Sts. Estimated cost $1,000,000. Trowbridge & Livingstone, 527 5th Ave., New York, N. Y., are architects. Tenny & Ohmes, 101 Park Ave., Pittsburgh, are mechanical engineers.

Tex., Coleman—O. D. Dillingham, Abilene, awarded contract for the construction of a 20 ton ice plant and creamery here to Edgerton & Furry, Coleman. Estimated cost $32,000.

Tex., Crosby — Crosby Ice Co., c/o C. R. Waters, is having preliminary plans prepared for the construction of a 12 ton ice plant, electrically operated. Estimated cost $28,000.

Tex., Gorman—Texas Water Utilities Co., subsidiary of General Waterworks & Electric Corp., 120 Broadway, New York, N. Y., plans the construction of a cold storage plant here.

Vermont—Advisory Commission, H. Barker, Secy., 11 Park Pl., New York, N. Y., is having preliminary surveys made for the construction of storage dams near Montpelier and Barre. $1,000,000 to $2,000,000 each. This is part of flood control and hydro-electric program. Total estimated $70,000,000.

B. C., Vancouver — Royal Bank, 400 West Hastings St., awarded contract for the construction of a 17 story bank and office building at Hastings and Granville Sts. to Carter-Halls-Aldinger Co., 510 Hastings St. W. Estimated cost $1,500,000.

Wis., Port Washington—Milwaukee Electric Railway & Light Co., 215 Sycamore St., Milwaukee, is having plans prepared for the construction of a 300,000 kw. power plant here. Estimated cost $25,000,000. F. Luber, c/o owner, is engineer.

Equipment Wanted

Boilers, Etc.—East Boston (Boston P. O.) **Mass.**—J. F. Gray, 15 Lewis St., plans to purchase boilers, tanks, etc.

Pumps—Grand Haven, Mich.—City plans to purchase pumps and equipment for proposed sewage system and sewage disposal plant. Estimated cost $200,000.

Pumps, etc. — Iola, Kan. — City will receive bids until Dec. 17, for 1,000 g.p.m. service pump, 3,500 g.p.m. filter wash pump, 1,000 and 1,400 g.p.m. auxiliary low service pumps, switchboard, etc. for proposed waterworks improvements. Estimated cost $100,000.

Pumps—Oklahoma City, Okla.—City plans the installation of four 4,000 g.p.m. motor driven centrifugal pumps for proposed waterworks improvements. Estimated cost $30,000.

Pumps, Etc.—Bismarck, Mo.—City will soon receive bids for one 250 g.p.m. centrifugal pump and motor, one 250 g.p.m. fire pump, one 100 g.p.m. deep well pump, etc. for proposed waterworks. Estimated cost $47,000.

Industrial Projects

Calif., Los Angeles—Victor Talking Machine Co., North Sycamore Ave., awarded contract for a 1 story, 90 x 161 ft. addition to factory to Austin Co. of California, 777 East Washington St. Estimated cost $75,000.

Conn., Middletown—Wilcox Crittenden & Co., Inc., 3 South Main St., is receiving bids for the construction of a 1 and 2 story, 100 x 190 and 25 x 45 ft. foundry and boiler house at Pameacha Ave. and High St. Estimated cost to exceed $40,000. Lockwood Greene Co., Inc., 24 Federal St., Boston, Mass., are engineers.

Conn., New Haven—F. Hartler, 118 Lawrence St., is receiving bids for the construction of a bologna plant, including cold storage plant on State St. Estimated cost $45,000. T. P. Appel, 185 Church St., is architect.

Ind., Speedway City—Electric Castings Co., awarded steel contract for a 1 story, 54 x 200 ft. factory, to Hetherington & Berner, 701 Kentucky Ave., Indianapolis. Estimated cost $44,000.

Ky., Louisville—W. P. Brown & Sons Lumber Co., 2531 South 4th St., is having plans prepared for the construction of a wood preserving plant, including oil storage tanks, two treatment cylinders each 8 x 126 ft., etc., on Highland Park. Estimated cost $700,000. F. B. Shipley, Koppers Bldg., Pittsburgh, Pa., is architect and engineer.

Me., Bucksport—Maine Seaboard Paper Co., W. S. Wyman, Pres., Augusta, awarded contract to Morton C. Tuttle Co., Park Sq. Bldg., Boston, Mass. for complete plant for the manufacture of newsprint including water supply, dredging and dock construction, etc. Mill will use electric power from Wyman Dam, now under construction.

Mich., Detroit — A. J. Bopp, 4-237 General Motors Bldg., is having plans prepared for the construction of a 1 story, 60 x 400 ft. factory for the manufacture of cold rolled sheet steel on Tireman Ave. Estimataed cost $75,000. C. W. Brandt, 2111 Woodward Ave., is architect. Electric motors and rolling equipment for strip steel will be required.

Mich., Detroit—C. W. Ditchy, 415 Brainard St., Archt., is receiving bids for a 1 story, 180 x 200 ft. drill factory on Davison Ave. for American Twist Drill Co., 2804 West Jefferson Ave. Estimated cost $100,000.

Mich., Lansing — Motor Wheel Corp., South Saginaw St., had plans prepared for the construction of a 2 story, 80 x 480 ft. wheel factory on South Saginaw St. Estimated cost $250,000. Private plans. Electric motors, etc. will be required.

N. Y., Corning—Corning Glass Co., awarded contract for the construction of a 1 and 2 story, 140 x 450 ft. factory and boiler house to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost $600,000.

N. C., Asheboro—Asheboro Chair Co., J. O. Redding, Gen. Mgr., plans the construction of a 60 x 190 ft. chair mill including finishing building, dry kiln, etc.

O., Barberton—Pittsburgh Plate Glass Co., awarded contract for the construction of a 2 story factory to Clemmer-Noah Co., Akron. Estimated cost $50,000.

O., Carrollton—Tusean Tire & Rubber Co., plans the construction of a 1 story, 40 x 180 ft. factory for the manufacture of rubber sundries. Estimated cost $40,000. Private plans.

Wis., Liel—Liel Furniture Co., will build a 3 story, 66 x 102 ft. factory. Van Ryn & DeGeleke, 114 Wisconsin Ave., Milwaukee, are architects.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICES of electrical supplies remain firm and unchanged at November levels. Cold-drawn steel is down 10c. per 100 lb., to $3.50 for round or hexagonal and $4 for flat or square, at New York warehouses. Linseed oil declined ½c. per lb. (16c.) f.o.b. Chicago. Babbitt metal quotations are lower this month by 1 to 2c. on the higher and ½c. per lb. on the cheaper grades.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 60c. per ft.
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50%
	Air—Best grade	
¼-in., per ft.	3-ply $0.30	4 ply $0.36
	Steam—Discounts from List	
First grade 40%	Second grade 45%	Third grade 50-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade 50% Second grade 60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—For cut, best grade, 30-5%; 2nd grade, 45-5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30-5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.30 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots up to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.16
New York (100 lb. bales)	.12½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.152	$0.164	$0.16

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	14.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, $\frac{7}{16}$-in. diameter and smaller, list (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.80
Pittsburgh mill	3.10

*Price is for full kegs; broken-keg lots are $6.00 net, delivered.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	56.00
Commercial genuine, intermediate grade	42.00
Anti-friction metal, general service	31.00
No. 4 babbitt (f.o.b.)	11.50

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.50	$3.65	$3.60
Flat or square	4.00	4.15	4.10

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65–5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	62%	50½%	1 and 1¼	31%	15%

LAP WELD

2	55%	43½%	2	23%	9%
2½ to 6	59%	47½%	2½ to 3½	28%	13%
7 and 8	56%	43½%	4 to 6	30%	17%
9 and 10	54%	41½%	7 and 8	29%	16%
11 and 12	53%	40½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60%	49½%	1 to 2	34%	18%
2 to 3	61%	50½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53%	42½%	2	29%	13%
2½ to 4	57%	46½%	2½ to 4	34%	20%
4½ to 6	56%	45½%	4½ to 6	33%	19%
7 and 8	52%	39½%	7 and 8	31%	17%
9 and 10	45%	32½%	9 to 12	21%	8%
11 and 12	44%	31½%			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mehanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3¼	30.25	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller	5c. per cut.	3 in.	9c. per cut.
2¼ and 2½ in.	6c. per cut.	3½ to 4 in.	10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid	$33.85 (net)	$48.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:	BX	Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft.	60%	34%
1,000 to 5,000 ft.	63%	36%
5,000 ft. and over	65%	48%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. No delivery charges, regardless of quantity.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
½	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less Than $10 List	$10 List to $100	$100 List and Over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$21.50
No. 16 cotton reinforced heavy		25.00
No. 18 cotton reinforced light		15.50
No. 16 cotton reinforced light		22.00
No. 18 cotton Canvasite cord		17.00
No. 16 cott n Canvasite cord		27.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$70.80	*76.70
No. 14 super service cord or similar (2 wire) in 1,000 ft.	106.20	*115.05

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
REFILLS—				
1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500), per 100	$2.80
0-30 ampere, less than standard package, per 100	3.10

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	.....	.....
60	A 21	.20	...	.....	.....
100	A 23	.35	...	.....	.....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.50	$8.90	$11.20	$19.00
12	9.90	11.40	14.00	25.00
10	13.50	15.40	18.50	33.50
8	19.90	22.50	25.00	47.50
6	.....	.....	36.00	.....
4	.....	.....	52.00	.....
2	.....	.....	72.00	.....
1	.....	.....	97.00	.....
0	.....	.....	119.00	.....
00	.....	.....	143.00	.....
000	.....	.....	176.00	.....
0000	.....	.....	215.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 31c. per lb.; in 100 lb. lots, 29c. per lb.
Rubber tape, ¾ in., in less than 100 lb., 33c. per lb.; in 100 lb. lots, 31c. per lb.
Wire solder, in less than 100 lb., 33c. per lb.; in 100 lb. lots, 31c. per lb.
Soldering paste, 2 oz. cans ..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	40%
Less than standard package	35%